ASPECTS OF PHONOTACTICS IN TYPICALLY DEVELOPING TELUGU SPEAKING CHILDREN (3-6 YEARS)

Registration No. 05SLP010

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A Dissertation Submitted in part fulfillment of Master's degree
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APRIL, 2007

Dedicated to My

Beloved Master Chariji

&

My Parents

CERTIFICATE

This is to certify that this Dissertation entitled **"Aspects of phonotactics in typically developing Telugu speaking children (3-6 years)"** is a bonafide work in part fulfillment for the master's degree (Speech-Language Pathology) of the student (Registration No. 05SLP010). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This Dissertation entitled **"Aspects of phonotactics in typically developing Telugu speaking children (3-6 years)"** is the result of my own study and has not been submitted earlier to any other university for that award of any degree or diploma.

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INTRODUCTION

Development of oral language is most natural and an impressive achievement in children. One of the most intriguing aspects of language development is the rapidity and apparent ease with which children acquire mother tongue resembling their adults. In this process, children acquire adult phonology by learning rules of that particular language. Every language in the world has specific rules which define phonetic sequences in various word positions. Such rules which define the word and syllable patterns (shape and size) are called the *phonotactic constraints* of the language. The phonotactic rules reflect a variety of different factors in a language, including the following:

- The number of syllables that tend to occur in each word
- The numbers, types, and locations of consonants in clusters
- The presence or absence of final consonants
- The presence or absence of diphthongs or long vowels
- Harmony patterns, in which consonants or vowels become more similar to each other
- Phrase-level effects, which change the pronunciations of sounds in phrases and sentences.

As compared to adult phonology, child phonology differs significantly with respect to phonotactics. The critical significance of syllable-level and word-level analysis for describing and explaining child phonologies in all languages has been increasingly

recognized over the past two decades, beginning with Ferguson and Farwell (1975), Macken(1979), and others. Ingram (1978) listed four main reasons for focusing on syllable and word structure in child phonologies:

1. Some phonological patterns, such as consonant cluster reduction and final consonant omission, function primarily to simplify syllables.
2. Other processes, such as unstressed syllable deletion and reduplication, operate only on entire word.
3. The development of many segments differs according to their placement within the syllable or word, in a given language.
4. Segmental complexity (difficulty and variety of sounds within the word) interacts with syllabic complexity (the shape of the syllable) and triggers word-level processes (such as harmony patterns). As segmental complexity increases, syllabic complexity may decrease, and vice versa. In other words, the child may be able to produce either difficult sounds or difficult word shapes, but not both within the same word.

Majority of the children of all languages begin phonological acquisition with CV as core syllable. However this preference of acquisition of syllables with onset is not a universal phenomenon. For instance in Portuguese language, Freitas (1996) reported that children in their early stages of word acquisition produced vowel-initial syllables. On the basis of data drawn from children speaking different western languages including English, Ingram (1986) reported some common tendencies in phonological acquisition in children between ages of 1.6 and 4.0 years. It was observed that children often resort to

phonological processes, with simple syllable structures and in most of the children, the direction of such simplification was towards a basic CV syllable.

Many investigators believe that phonological development in early years of a child is exclusively word or syllable based and that children's early phonological systems do not usually refer to the segmental level. Syllable or word-level patterns such as harmony, assimilation, and reduplication are more applicable to describe child phonologies as they are frequently found in them. Further more, clinical impressions of clients by many Speech-Language Pathologists have indicated that clients of any age generalize their learning much better when sounds are targeted at the syllable or word level rather than in isolation (Velleman, 1998). This condition is more reflected in case of children with Developmental Apraxia of Speech (DAS). Although children with DAS experience difficulty in producing various segments in isolation and in words, major difficulty lies in producing these segments together in a smooth and coherent manner

Need for the study:

Children implicitly learn the rules of their language including phonotactic patterns as they develop. However many children with disordered phonologies experience phonotactic as well as phonetic limitations. Sometimes a child may produce consonants and vowels that are age-appropriate, but may be unable to use them in the configurations as required by the language. An observation of these trends in children is crucial for a Speech-Language Pathologist. It becomes essential to have a sound knowledge about the

phonotactic constraints in a language and their development in children, so that one **can** compare the pattern seen in children with disordered phonologies. The norms of one language cannot be applied to other languages. Hence there is a need for the development of normative data in Indian languages with respect to phonology and specifically phonotactics. In addition to subserving the need for normative data, it assists in identification of phonological deficits based on the phonotactic rules and thus helps in selecting appropriate procedure for treatment and selecting goals during therapy.

Aim of the study:

To establish a database on the frequency of occurrence of the following in the speech of typically developing children speaking native coastal Telugu dialect (central dialect) in the age range of 3 to 6 years:

a) Syllable shapes (CV, CVC, VC, V and C) and word types (monosyllabic, disyllabic, trisyllabic and multisyllabic)
b) Position of clusters (initial, medial, final) and types of clusters (-CC-, -CCC-, geminated and non-geminated clusters)
c) Word or phrase level patterns like harmonized vowels, harmonized consonants and reduplicated syllables.

Method:

Elicited spontaneous speech samples were collected from 60 normal children speaking South Coastal Telugu dialect between age ranges 3-6 years. A 100-word sample was selected and was transcribed using IPA (Broad phonetic transcription method). Further, syllabification of the utterances was carried out and percentage occurrence of various syllable shapes, word types, position of clusters, types of clusters and phrase-level patterns were calculated. Intra and inter-judge reliability measures were also done for the randomly selected samples.

Implications:

> The normative data obtained can be used to compare with disordered population especially children with phonological disorders and Developmental Apraxia of Speech.
> The study promotes the importance of developing language based normative data as each language differs from others in terms of phonotactics.
> In depth analysis of child's phonology is possible which aids in accurate assessment.
> Data obtained can be of useful in setting therapy goals according to developmental patterns.

Limitations:

> There is need to study the acquisition of phonotactics in subjects with wider age range (lesser then 3 years and greater than 6 years)

> Detail information on the interaction of phonetic and phonotactic development was not investigated due to time constraints.

> Phonetic repertoire of children was not investigated.

REVIEW OF LITERATURE

Phonology is defined by Crystal (1991) as "a branch of linguistics which studies the sound systems of languages". Phonology encompasses range and function of sounds in specific languages. It is also concerned with rules which determine type of phonetic relationship that relate and contrast words and other linguistic units (Crystal, 1991). Edwards and Shriberg (1983) identified two different properties of phonology with respect to:

- Overt speech
- Covert speech

Overt speech is comprised of the speech sounds which are produced, heard and perceived. It is the end product of muscle movements (articulatory movements) that generate these speech sounds. On the other hand, covert speech is the formulation of sound sequences based on the knowledge of phonologic system of a given language. This includes usage of rules of how phonemes can be combined to form words.

Stoel-Gammon and Dunn (1985) pointed out that phonology includes all aspects of the speech system and the production of speech sounds. They described two levels of analyses viz.. Phonetic analysis and phonologic analysis, which allows for complete understanding of the phonology of the given language.

Phonetic analysis of the sound system of a language encompasses three aspects:

a. Analysis of articulatory dynamics or the way sounds are formed by the speech mechanism

b. Analysis of acoustic or the physical component of speech sounds

c. Analysis of psychological perspective or the way sounds are perceived by the listener.

Phonological analysis of a sound system includes four aspects:

a. Inventory of the phonemes of a particular language

b. Description of patterns and the use of these phonemes

c. Description of the phonemes as pronounced in various phonetic contexts or the allophonic variations

d. Description of morpho-phonemic alterations in sound patterns.

According to Velleman (1998), phonological system of any given language includes basic elements (features, which combine to form phones) with assigned roles (transforming phones into phonemes), which are combined in specific manner into larger units (syllables and words). All of these elements interact in certain ways (referred to as processes or constraints or rules) at specified rates and levels (the prosody) to achieve the final result that is, the spoken language. All of these elements, levels and interactions are defined as follows:

- **Phonotactic repertoire:** refers to syllable and word shapes available for use
- **Phonetic repertoire:** refers to sounds (and features) available to form the content of the syllables and word shapes.
- **Phonemic repertoire:** refers to interaction of the syllable, word and phrase shapes with the sounds and sound contrasts to yield the final pronunciation of an

utterance, and the influence of morphological structure of a language on the pronunciation of different types of words and word endings.

- **Suprasegmental patterns or prosody:** refers to the position of stress in the word or sentence. It also includes influence of parameters like loudness, pitch, duration on the stress patterns.

Edwards & Shriberg (1983) defined *Phonotactics* as the rules for how sounds can be combined to formulate syllables and words and how these sounds can be distributed in a given language. Phonotactic rules increase the ease of production. Some rules operate exclusively at syllable level while others operate at word or phrase level. A variety of factors that influence the phonotactic patterns of languages are discussed below:

1. *Number of syllables in a word:* Segments grouped together in systematic ways forms a prosodic hierarchy. A smallest group of segments is the syllable. A syllable is divided into two major constituents, the 'onset' and the 'rhyme'. Rhyme consists of a prominent phoneme called 'nucleus' and 'coda'. 'Nucleus' or 'peak' is relatively long and or of high amplitude. The 'coda' is the entire sequence of syllables to the right of the 'nucleus'. The 'onset' consists of the string of consonants before the 'nucleus'. An important factor that determines the phonotactic rules or constraints at the level of word include the number of syllables that occur in a word. Generally it is found that in majority of the languages across the world monosyllabic words are most commonly used by speakers although specific upper limit on the number of possible syllables in a word is not definite (Crystal, 1987). The number of syllables in a word

is inversely proportional to its frequency of occurrence (Crystal, 1987). For instance English language tends to have shorter words on an average. However some languages like Japanese and Hawaiian tend to have far more multisyllabic words than others (Crystal, 1987).

2. *Vowel as syllable nucleus:* Majority of the languages in the world have vowel as the nucleus of a syllable. However, if consonants serve this purpose they are called as syllabic consonants. For example, English allows a consonant that is nasal or liquid to carry entire syllable in words such as *button* or *bottle* (Velleman, 1998). Out of 182 languages representing the major language families and areas of the world, Bell (1978) reported that 85 languages have syllabic consonants. Out of these, 71 languages showed resonant consonants (nasals and liquids) as most frequently occurring type in the syllables and also within them 24 languages showed obstruent consonants (stop or fricative). Only 10 languages allowed obstruents but not resonants to act as the nucleus of a syllable.

3. *Consonant as a syllable onset:* In majority of the languages, consonants occur as syllable onset. Blevins (1995) found that languages with vowels as the initial syllables are more common than languages that do not. Languages that allow only consonants as syllable onsets use strategies like epenthesis (insertion of consonant as onset of the syllable) for borrowed words (Mc Carthy & Prince, 1995).

4. *Open versus Closed syllables:* A syllable without a coda is an open syllable. A syllable with a coda is a closed syllable. Languages prefer open syllables over closed syllables, and open syllables occur more frequently than closed syllables (Bernhardt & Stemberger, 1998). Crystal (1991) posited that all languages have CV syllables (open syllables) and very few languages have no CVC syllables (closed syllables). For instance, Hawaiian language allows only V and CV syllables. It compensates for its limited syllable variety with the presence of extremely long words (Velleman, 1998).

5. *Consonant clusters:* Number of consonants that are allowed in consecutive order in various word positions and the order of consonant types within clusters differ in various languages. For instance, Japanese language has almost no consonant cluster and only one specific type of consonant (/n/) occurs in the final position. Such languages have more number of lengthy multi-syllabic words (Hyman, 1975). In English, a wide variety of clusters occur. But in casual or fast speech, English speakers tend to delete and simplify clusters. Such simplification is also evident in long clusters that are created by adjoining two words into a phrase. Simplification may include omissions, coalescence, epenthesis, metathesis, and migration (Clark & Yallop, 1995).

6. *Sequences of vowels:* One-third of the world's languages include dipthongs and many incorporate distinction between long versus short vowels in their language (Ladefoged & Maddieson, 1996). Languages that do not allow two consecutive

vowels typically use strategies like deletion or epenthesis to eliminate production of vowels in a sequence. Such deletion is commonly seen in phrases leading to contractions such as *I'm, you 're* and so on (Clark & Yallop, 1995).

7. *Whole-word or phrase level phonological patterns:* Phonological processes can be grouped into two functionally distinct categories: *Whole-word processes,* which simplify word or syllable structure and segmental contrast within a word (generally through reduction or assimilation), and *segment change processes,* which involve (context-free) changes in specific segments or segment types, regardless of syllable- or word-position (Bernthal & Bankson, 1993). Assimilatory processes (like consonant harmony) take the whole word as their domain, whereas reduction processes (involving consonant or syllable deletion) alter the phonotactic or syntagmatic structure of the adult model, reducing the number of syllables or simplifying the shape of syllables. All these processes are often treated together and are referred to as "phonotactic rules" (Ingram, 1974), or "syllable structure processes" (Ingram, 1986), or "structural simplifying processes" (Grunwell, 1981). Technically, assimilation is described as adjacent elements becoming more alike, like in instance where negative prefix in- is added to the word *possible* to yield *impossible.* Harmony is defined as the more distant units becoming more alike (eg *doggie* becoming *goggie).* Reduplication is the process where one syllable is repeated (eg boo-boo, papa). The types of assimilation/harmony that may be obligatory in phonologies of few languages include consonant harmony or assimilation, vowel harmony, reduplication, consonant-vowel assimilation.

a) *Consonant harmony:* In adults, consonant harmony or assimilation is limited to certain words where consonants with in a word share common features like place or manner of articulation or voicing. According to Cruttenden (1978), Consonant harmony is rare in adult phonology and if harmony occurs, it affects consonants in similar syllable positions.

b) *Vowel harmony:* In some languages certain vowels within a word share certain features. Most commonly, vowels that occur within a word must agree by having the same height, the same backness or the same roundness. Poster (1982) provided an example in Turkish to explain that vowel harmony occurs in certain morphological conditions. In Turkish language, vowels in past tense suffix -dVm (where V stands for different vowels), must agree with previous vowel in the verb stem (Poster, 1982).

c) *Reduplication:* It can be defined as a combination of vowel and consonant harmony. Multi syllabic words are formed by repeating one syllable of the base word. This pattern is found commonly in baby-talk registers in some languages. However, some languages use reduplication grammatically in their everyday words. For instance in Walpiri (a language spoken in Australia) the plurals of some nouns referring to human beings are made by total reduplication i.e., the entire word is repeated to indicate plurality. Similarly speakers of Agta language use partial reduplication i.e., repeating single syllable to express a plural (Marantz, 1982).

d) *Consonant-vowel assimilation:* This accounts for change in consonant features to make it similar to adjacent vowel or vice versa. Consonant-vowel assimilation results in the palatalization of many alveolars in English words like *nature* (Hyman, 1975).

Non-linear phonology and phonotactics:

In 1970's, the field of speech-language pathology adopted analytical methods from the field of linguistics. Phonological process analysis was most the commonly used method for the description of a child's speech sound (phonological) disorders (Edwards & Bernhardt, 1973). In addition to developmental norms, factors such as the relative frequency of phonological processes, intelligibility, rule/ process ordering, and potential for generalization were considered relevant during goal selection. In recent years, non-linear phonological theory has provided a basis for new developments in phonological intervention (Bernhardt, 1992; Stoel-Gammon, 1994). Non-linear phonology addresses issues of primacy of the syllables and words in the child and adult phonologies of the languages of the world. Although rule-systems used by non-linear phonologies have now been replaced by a newer system known as Optiality theory, the elements and structure remain popular and relevant. In spite of the theoretical differences among various approaches of non-linear phonology, all approaches in common divide words into syllables.

Child phonology and phonotactics:

In terms of phonotactic patterns, child phonological system offers a different perspective in comparison to adult phonological system. The syllable appears to be an important unit in early sound patterns (vocalizations) and the development of syllabic organization of sounds act as a major framework for speech development. There is growing evidence that these vocalizations prepare the child for acquisition of a phonetic system (Bemthal & Bankson, 1993). According to Bernthal & Bankson (1993), the major phases in syllable development are as follows:

1. Continuous phonation in a respiratory cycle provides the basic phonatory pattern from which refinements in articulation can develop.
2. Intermittent phonation within a respiratory cycle breaks the basic pattern of continuous phonation and, thus, is a precursor of syllabic units.
3. Articulatory (supraglottal) movements interrupting or combining with phonation provide early experience in the control of co-occurring phonation and articulation
4. Marginal syllables (in isolation or in sequences) are early syllabic forms that, while lacking the detailed structure of adult syllables, prefigure the basic syllable shape
5. Canonical syllables (in isolation or in sequence) anticipate important structural properties of adult speech and may be particularly important in relating an infant and perceptions of adult speech with his or her own productive patterns.
6. Reduplicated babble (repeated syllable patterns) gives the infant experience with both prosody (especially rhythm) and sequences of articulations.

Majority of the children of the world languages begin phonological acquisition with CV as preferred basic unit (core syllable) of speech articulation. However the preference of this pattern of syllables with consonant onset is not a universal phenomenon. For instance in Portuguese language, Freitas (1996) reported that children in their early stages of word acquisition produced vowel-initial syllables. In comparison with open syllables (CV and V) closed syllables (CVC) is not reported to emerge until the child has acquired 8-11 different consonants at approximately 2.5 years (Grunwell, 1982). During later babbling periods, open syllables are still the most frequent type of syllables. Kent & Bauer (1985) reported that syllable shapes V, CV, VCV and CVCV accounted for approximately 94% of all syllables produced. Although closed syllables were present, they were found to be very limited in the repertoires of these infants. Phonotactic constraints on clusters are common among young children belonging to any linguistic environment. In English-speaking children of 24-months, Stoel-Gammon (1987) reported that 58% use 2 element clusters in initial position, 48% in final position and 30% in medial position.

Children's phonology may be less systematic in early stages of word learning. It could become more systematic as the mastery of syllable and word shapes takes place through an extensive period of prelinguistic speech practice (babbling) and then by the use of their best-learned shapes as the basis for words. Jacobson (1968) postulated a universal order of syllable acquisition. He indicated that the first syllable structure to develop was consonant vowel (CV) or CV reduplicated, followed by CVC and CVCV

(differentiated). In case of English, the development sequence was reported by Shriberg (1993) and this is shown in Table 1.

Table 1: Age of acquisition of syllable shapes and number of syllables in English speaking children (Shriberg, 1993)

Age of acquisition (years)	Syllable shapes and number of syllables
2	CV, VC, CVC and 2-syllable words
3	Word initial and word final consonant clusters
4	Words with 3-syllable and more consonant clusters
5	Words with more than 3 syllable
6	All syllable structures as seen in adult language are acquired

The CV syllable, occurring in virtually all of the world's languages, has long been recognized as a preferred basic unit of speech articulation (Bernthal & Bankson, 1993). This syllable form is one of the earliest syllables to be identified in infant vocalizations. The vocalizations of 1-year-olds are predominantly, simple V or CV syllables and their elaborations like VCV, CVCV (Kent & Bauer, 1985). Branigan (1976) regarded the CV syllable as a training ground for consonant formation. Most consonants are produced first in the initial position of CV syllables and then, later, in post vocalic (e.g., VC) position. Branigan (1976) examined single word productions of a child at 16 months of age and reported following consistent patterns:

1. The words were primarily open monosyllables.

2. The vowels were primarily those which were most widely separated in the vowel quadrilateral. The most frequently occurring vowels were back vowels.
3. All consonants were stops, nasals and glides.
4. All bisyllabic utterances were reduplications.

There is also evidence to suggest that early CV syllable production is linked in a developmental chain, to early word production and to the articulation of word-final consonants (Menyuk, Liebergott & Schultz, 1986).

Word-level or phrase-level patterns such as harmony, assimilation, and reduplication are more applicable to describe child phonologies as these features are frequently found in them. On the basis of data drawn from children speaking different western languages including English, Ingram (1986) reported some common tendencies in phonological acquisition in children between ages of 1.6 and 4.0 years. It was observed that children often resort to phonological processes, with simple syllable structures and in most of the children, the direction of such simplification was towards a basic CV syllable. Edwards and Shriberg (1983) postulated that children use "strategies" in forming adult like utterances. Some of these strategies are as follows:

- *Selection or avoidance of hard sounds:* tendency to avoid using difficult sounds such as fricatives or consonant clusters.
- *Avoidance of homonymy:* tendency for not using words which sound the same within current phonological system. Instead they may avoid a word or use alternative pronunciations in order to distinguish between a homonymous pair of words.

- *Use of homonymy:* some children may use this strategy where one sound combination is used to refer to several words. Different children seem to have varying tolerance levels for homonyms in their speech with some choosing to avoid homonyms while others use homonyms to increase their speaking vocabulary.
- *Limited output patterns:* children use a structural pattern to form various words. E.g., one of the child described by Edwards and Shriberg (1983) produced monosyllabic words initiated by a consonant /d/ followed by a vowel.
- *Absolute position constraints:* occurrence of certain sounds or features exclusively in a particular word or syllable position.
- *Harmony:* Under this category Edwards and Shriberg (1983) described two strategies. The first one is assimilation/ harmony of sounds which is the tendency to make the sounds in a word more similar than in the adult form. The other strategy or process, reduplication, occurs when two syllables of a disyllable words are produced more alike than the adult form, or the same syllable is repeated.

Schwartz et al. (1980) postulated reduplication as a strategy for avoiding the use of final consonants. In this study it was found that many of the reduplicating children failed to produce non-reduplicated multisyllables indicating that reduplication is one of the means to increase the syllabic length without increasing segmental complexity. Davis and MacNeilage (1990) reported consonant-vowel interdependency in a child in the earlier stages of phonological development. The child demonstrated a strong tendency to

produce high front vowels with coronal consonants, high back vowels with velar consonants and low vowels with labial consonants. Earlier to this connection Stoel-Gammon (1983) reported some patterns occurring in one of the child, which were conditioned by the vowel. Among them most frequently occurring pattern was substitution of labial consonant by an alveolar consonant whenever labial consonant is immediately followed by vowel. For instance child produced bubble, bottle and ball with an initial [b], but bye-bye as [daidai] and baby as [didi] produced with an initial [d]. Distribution requirements determine the types of sounds that can occur in certain syllable or word positions. They are not restrictions on the phonetic repertoire of the entire language but on the place and manner in which specific phones function within the language. The term "Word recipe" (Menn, 1978) is used to indicate phonotactic templates that are specific syllable or word patterns which are dominant in a child's repertoire. This child-specific phonotactic pattern is to avoid certain difficult word shapes of adult form. At the same time they would help in expanding their vocabulary by changing the shapes of other difficult words to fit in their preferred shape (Waterson, 1971). The establishment of these word-recipes in child phonology is speculated as regressing (Velleman, 1998). However such apparent regression reflects the onset of phonological systematization. They demonstrate that the child is no longer memorizing words as whole but is trying to discover the patterns and rules of the adult phonology. Hence word recipes are considered as "Harbingers of phonological development" (Velleman, 1998).

Telugu language

Telugu belongs to the Dravidian language family. Telugu constitutes the largest of all the Dravidian languages with more than 60 million people speaking this language. It has been the official language of Andhra Pradesh State since 1966. There are four major dialects in Telugu (Vasanta, 1995):

a) Northern-spoken in the nine Telangana districts
b) Southern-spoken in the four inland districts of Rayalasima together with Prakasam districts
c) Eastern-spoken in vishakhapatnam and srikakulam districts
d) Central-spoken in Mid coastal districts of East and West Godavari, Krishna, Nellore and Guntur. Present study considered the central dialect of Nellore district.

Phonetic features of Telugu

The central dialect of Telugu has as many as 43 segmental phonemes of which, 33 are consonants, and 10 are vowels in addition to two diphthongs and aspirated consonants. Consonant clusters occur primarily in word medial position in Telugu. Telugu language has no final consonant clusters in native vocabulary (Nagammareddy, 1987). In the initial position they occur rarely in loan words and typically take the form stop+ /y/ or /w/ or /*x*/ or /l/ clusters. The clusters operating on the native vocabulary are primarily geminates (/kk/, /tt/, /pp/, etc); nasal+homorganic stops (/nt/, /nd/, /ng/, /mp/, /mb/, etc); stops or affricates combined with /y/, /*r*/,/*l*/and /w/. In all the clusters,

fricatives can be followed by a plosive, but not vice versa. The trill /r/ can occur after any major consonant types other than an affricate. Semi vowels do not occur before voiced aspirated stops. Nasals do not occur after breathy voiced stops. Similarly nasals do not occur after aspirated consonants and affricates. Three consonant clusters occur in medial position of Telugu language. In Telugu, all the word-medial three consonant combinations contain the permitted two-consonant combinations. The permitted combinations are fricative+plosive+trill; nasal+obstruent+liquid/semivowel (Vasanta, 1995). Word initial three consonant clusters are borrowed words from Sanskrit or English languages (Nagammareddy, 1987).

Indian studies on phonotactics in normal children

Phonotactic patterns in spoken language of children in Indian languages are not well reported. Rupela & Manjula (2006) analysed some aspects of phonotactic patterns of thirty normal Kannada speaking children between age range 0 and 5 years. Results indicated that CV syllables were easier compared to VC and CVC. Monosyllables were rarely found compared to others and disyllables were most common followed by trisyllables and multisyllables. In Telugu language (telangana dialect), Nirmala (1981) studied four children in the age range 1.6 - 3.0 years over a period of six months. Controlled elicitation and free conversation were used to collect data from the children. Results revealed that in the order of acquisition among consonants, nasals appeared first, followed by stops affricates and semi-vowels. Voiceless phonemes were acquired earlier than voiced ones. Contrasts among the voiceless stops and nasals were established before

the voiced stops affricates and semivowels. Aspirated phonemes were acquired by 3.5 years at which point the distinction between retroflex versus non-retroflex sounds was still emerging. Glottal fricative /h/ had no substitutes and it was deleted in the speech of all four children until the age of 3.5 years. There were many substitutions among medial consonantal clusters produced by 2.6 to 3.5 year-olds. Geminate and homorganic clusters were acquired earlier than the others. Telugu words typically ended in open syllables. Two syllable words were more common than three or tetrasyllabic words. Syllable reduction was observed mainly with respect to three syllable words. Nirmala (1981) also observed reduplication tendency in one of the child from 1.6 to 1.11 years.

No studies till date have reported syllable patterns in Telugu speaking children above 3 years of age. Hence present study was planned to obtain a database for phonotactic pattern seen in typically developing Telugu speaking children between the age range of 3 and 6 years. The focus of this study is restricted to obtain frequency of occurrence of various syllables, word shapes, position of clusters and phrase-level patterns from 100 word sample (continuous conversational speech samples).

METHOD

Analysis of phonotactic repertoire forms an important aspect in understanding the development of phonological abilities in typically developing children. It helps to gain insight regarding the actual phonological capabilities and limitations of a given child. There is a need to establish normative data of phonotactic repertoire in order to compare deviant phonological pattern shown by children with various disorders. The present study was planned to investigate phonotactic patterns seen in typically developing Telugu speaking children.

The study aimed to investigate the frequency of occurrence of the following in the speech of typically developing children speaking native coastal Telugu dialect (central dialect) in the age range of 3 to 6 years:

a) Syllable shapes (CV, *CVC*, VC, V and C) and word types (monosyllabic, disyllabic, trisyllabic and multisyllabic)
b) Position of clusters (initial, medial, final) and types of clusters (-CC-, -CCC-, geminated and non-geminated clusters)
c) Word or phrase level patterns such as harmonized vowels, harmonized consonants and reduplicated syllables.

Subjects:

60 normal children speaking south coastal Telugu dialect between age ranges of 3 and 6 years were included. Equal number of males and females were included and they were divided into six groups with an age interval of six months, as 3.1-3.5 years, 3.6-4.0 years, 4.1-4.5 years, 4.6-5.0 years, 5.1-5.5 years, and 5.6-6.0 years. 10 children were included in each group. The children were selected randomly from an English medium school in Nellore district of Andhra Pradesh, where Telugu (Central dialect) is spoken as primary language by majority of the population.

Subject selection criteria were as follows:

- Telugu language (central dialect) was the mother tongue of all the children and English was used as medium of instruction at school.
- The speech and language milestones of all the children were normal. As there is no standardized test available in Telugu language for assessing language of children between age range of 3 to 6 years, language level was determined by informal testing and also based on teacher's report on child's academic performance. Poor academic achievers and children with articulatory errors were excluded from the study.
- The children had no hearing, vision problems, oro-motor and structural abnormalities as assessed on screening tools. The ones who tested positive for these were excluded from the study.
- All the subjects belonged to middle socio-economic status.

Data collection:

Elicited spontaneous speech samples were obtained from the subjects by the investigator. The samples were recorded in a quiet room in the school set up. A sample of continuous speech is reported as the most valid means of determining the frequency of occurrence of specific syllable structure in a language (Morrrison & Shriberg, 1992). Conversation also reflects the child's habitual speech in actual communicative settings (Creaghead, Newman & Secord, 1989). Spontaneous speech was elicited from the subjects by asking probing questions on daily routines of the child e.g., play situation. Children were also encouraged to speak spontaneously while playing using appropriate stimuli (doll, toy farm animals, vehicles, picture book, action pictures depicting routine activities etc.,), when children were not comfortable with general conversation. These stimuli were kept constant across all the children. All the samples were recorded using a digital voice recorder with an external microphone which was placed approximately 10 cm away from the child's mouth.

Analysis:

From the corpus, a sample of 100 utterances was selected as this is considered as representative sample (Grunwell, 1982). Leaving few utterances in the initial positions of the samples (10-15 utterances), the subsequent 100 utterances were selected for the analysis. These utterances were transcribed using IPA (Broad phonetic transcription

method) by the investigator. Different syllable shapes (only V, CV, VC, CVC etc), word shapes (monosyllabic, disyllabic etc), position of clusters (initial, medial and final), cluster types (-CC-, -CCC-, geminated and non geminated clusters), syllable- or word-level patterns, such as harmony and reduplication were anlaysed. For calculation of percentage of occurrence of various syllable structures (syllable shapes, word shapes and clusters in all positions) and word-level patterns (harmony, reduplication), the formulae given by Velleman (1998) were used.

E.g; a) For CV syllables:

$$\frac{\text{No. of CV syllables}}{\text{Total No of syllables}} \times 100$$

b) For monosyllabic words:

$$\frac{\text{No. of monosyllabic words}}{\text{Total No. of words}} \times 100$$

c) For initial consonant cluster:

$$\frac{\text{No. of initial CC}}{\text{Total No. of words}} \times 100$$

d) For harmonized consonant words:

$$\frac{\text{No. of harmonized C words} \times 100}{\text{Total No. of words with 2 or more Cs}}$$

e) For reduplicated words:

$$\frac{\text{No. of reduplicated words}}{\text{Total No. of multi-syllabic words}} \times 100$$

***Reliability**:*

Intra judge reliability: A week after completing the original scoring, the investigator randomly selected 10 % of the total samples and repeated the procedure of transcription. Reliability was calculated based on point-to-point percentage of agreement i.e., the number of items judged to be same was divided by the total number of items selected. Reliability index of 90% or above is suggested as good indicator for consistency in his or her judgments on two occasions (Bernthal & Bankson, 1993).

Inter judge reliability: To check the reliability of transcription inter judge reliability was done. An experienced Speech Language Pathologist transcribed 10% of the whole sample. The point-to-point agreement between the experienced Speech Language Pathologist and the investigator was done. This was converted into percentage to get reliability index.

Statistical analysis:

Percentage scores were computed and non-parametric statistics were used whenever appropriate to tabulate the results.

RESULTS & DISCUSSION

Analysis of phonotactic repertoire, which is one of the important aspects of phonology, has been considered in the present study. The study aimed to establish normative data on some aspects of phonotactics of Telugu (Central dialect) speaking children between age ranges of 3 and 6 years. Speech samples of 10 subjects each in 6-month age intervals were analyzed for different phonotactic patterns. Percentage occurrence of syllable shapes, word shapes and Clusters were calculated. According to percentage of occurrence obtained, they were categorized into 5 grades based on the index suggested by Velleman (1998).The same is shown in Table 2.

Table 2: Percentage scores and their corresponding frequency of occurrence

Percentage occurrence	**Category**
0%	Absent
>0-15%	Rare
>15-35%	Occasional
>35-50%	Frequent
>50-100%	Predominant

The results are discussed under 5 sections and they are as follows:

Section 1: Syllable shapes

Section 2: Consonant clusters

Section 3: Word shapes

Section 4: Phrase-level interactions

Section 5: Reliability measures

Section 1: Syllable shapes

The various syllable shapes found in the samples were CV, CVC, VC and V excluding clusters. As recommended by Velleman (1998) patterns CCVC, CVCC were considered as CVC, VCC was considered as VC and CCV was considered as CV. These considerations were made as cluster analysis was done separately. Table 3 shows the frequency of occurrence of various syllable shapes.

- CV syllables were 'predominant', having 62% of occurrence on an average and were most commonly occurring syllables compared to others.
- C syllable did not occur independently.
- The frequency of occurrence of CVC syllables was 30% falling under status of 'frequent' occurrence. These were most common types of syllables following CV type.
- The occurrence of VC and V syllables were below 10% and thus can be said to fall under 'rare' category.
- Graph 1 shows the developmental pattern for the different syllable shapes and it is evident that there is no significant change in the percentage occurrence of syllable shapes across ages 3-6 years. The predominance of CV syllable shape is consistent across age groups. CVC syllable shape had shown slight increase in frequency till 4.5 years and thereafter stabilized. This suggests that children have acquired syllable shapes by 3 years of age itself and then were maintained till 6 years of age.

Table 3: Mean percentage occurrence of different syllable shapes

Age (years)	CV		CVC		VC		V	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
3.1-3.5	67.06	4.19	24.83	2.81	4.03	1.93	3.34	1.90
3.6-4.0	60.31	10.39	29.54	8.98	6.54	2.07	3.35	1.43
4.1-4.5	58.67	7.56	35.58	10.35	6.33	1.75	2.42	1.50
4.6-5.0	61.98	7.64	30.40	6.58	7.50	6.59	3.47	3.47
5.1-5.5	63.45	3.99	29.05	6.31	5.62	1.47	3.12	1.44
5.6-6.0	63.31	2.85	30.06	3.05	4.07	1.02	2.05	1.17

One-way ANOVA was done to find whether there is significant difference of syllable shapes across age groups. This statistical result revealed that the syllable shape CVC was significantly different across six age groups [$F(5, 59) = 2.45$; $p < 0.05$]. Further, Duncan's post-hoc test was done to see pair-wise differences within CVC syllable shape. Findings indicated that greater significance was found between groups of 3.1-3.5 and 4.1-4.5 years at 95% confidence limit. Frequency of occurrence was similar for all the syllable types except CVC across ages of 3 to 6 years of Telugu speaking children.

Qualitative analysis of data revealed that, overall there were no words ending with CVC type except in few words where words ended with nasal /m/. Few examples are listed below: (Transcription is based on IP A, 2005 and same is shown in Appendix)

/gurrəm/ (horse)

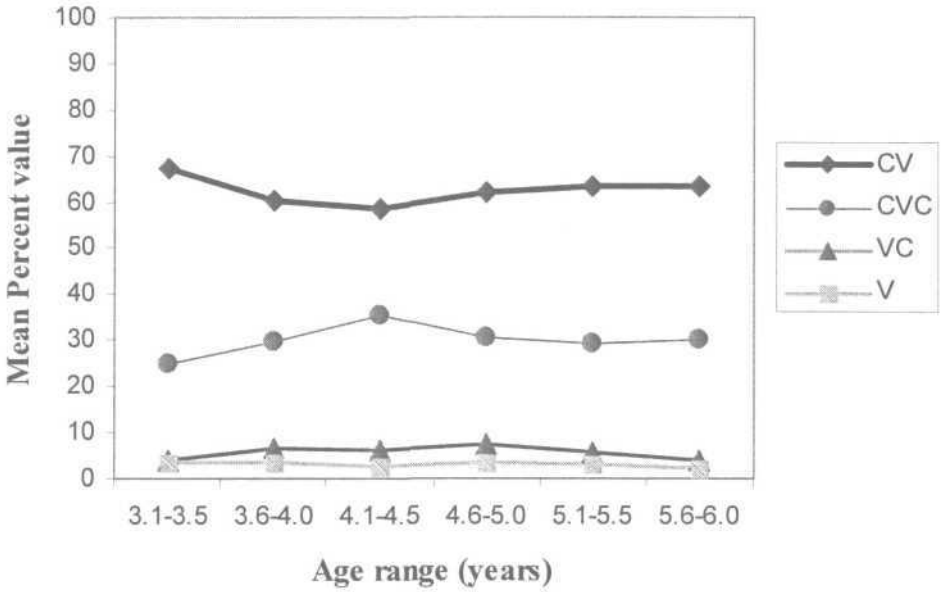
/panukunta:m/ (will sleep)

/annəm/ (food)

/ellæ:m/ (we went)

/va:rəm/ (week)

Graph-1: Mean percentage occurrence of syllable shapes



Apart from these Telugu words ending with CVC type, there were also few borrowed words from English used by these children, which also ended in CVCs like 'school', 'sister' and 'elephant'. These English adopted words occurred in about 5% of the entire samples on an average. This may be due to curricular influence as the medium of instruction of the subjects was English in the school. The V syllable type occurred in word initial position. Among them 70% of the times it was a long vowel or a diphthong. Few examples are listed below:

/a:vu/ (cow)

/a:du/ (play)

/aidu/ (five)

/a:pu/ (stop)

/i:le:du/ (didn't give)

Section 2: Consonant Clusters

The various consonant clusters found in the children's speech were initial clusters (CC-), medial clusters (-CC-), final cluster (-CC) and three sound clusters in the medial position. Medial clusters included both geminated (-CCg-) and non-geminated (-CCng-). Table 3 depicts the mean and standard deviation of percentage occurrence of various types of consonant clusters and Graph 2 depicts the developmental trend in the mean percentages across the different age groups. From Table 3 and Graph 2, following findings were evident:

- Among the cluster types, medial clusters occurred 'predominantly' with 60-70% of frequency. With in medial clusters geminated clusters occurred more 'frequently' occurring with a percentage of occurrence between 30-40%. This frequency was maintained across all age groups.
- Medial non-geminated clusters occurred with a frequency of 45-55%. Nasal + homorganic stops (/nt/, /nt/, /nd/, /nk/, */mt/* etc) were predominantly noticed in the samples followed by fricatives + plosive combination (-st-).

- Initial and final clusters occurred with a frequency of less than 3% and typically occurred in loan words across all age groups. Among them frequently used words were 'school', 'slate', 'class', 'first', 'park', 'scooter'.
- Three consonant clusters occurred medially with combination of nasal + stop + liquid combination (-ntl-). However frequency of such clusters was less than 3% and fell under 'rare' category across all the age groups from 3-6 years.

Table 4: Mean and standard deviation of percentage occurrence of clusters

Age (Years)	CC-		-CC		-CCg-		-CCng-		-CCC-	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3.1-3.5	1.14	1.37	0.48	1.87	33.16	8.96	45.61	12.79	0.62	1.05
3.6-4.0	0.90	1.49	0.72	1.11	36.58	12.79	55.19	16.29	1.27	1.89
4.1-4.5	2.05	1.37	0.73	1.15	42.69	12.39	57.12	17.93	1.81	1.55
4.6-5.0	2.05	1.70	0.27	1.57	43.49	8.07	54.84	12.29	1.94	1.80
5.1-5.5	4.05	2.24	0.35	0.59	34.26	12.65	62.04	11.96	1.98	1.56
5.6-6.0	2.16	1.46	1.28	0.73	41.26	10.38	65.61	12.79	2.16	1.41

One-way ANOVA was done to find the significant difference of cluster types across age groups. These findings revealed that there is significant difference of initial clusters [$F(5, 59) = 4.5; p < 0.05$] and medial non geminated clusters [$F(5, 59) = 5.8; p < 0.05$] among cluster types. Duncan's post Hoc test was done to see pair-wise differences. Results revealed that there was greater difference between 5.1-5.5 and 5.6-6.0 age groups

for initial clusters. For Non-geminated clusters pair wise comparisons revealed significant differences across various age groups as depicted in Table 5.

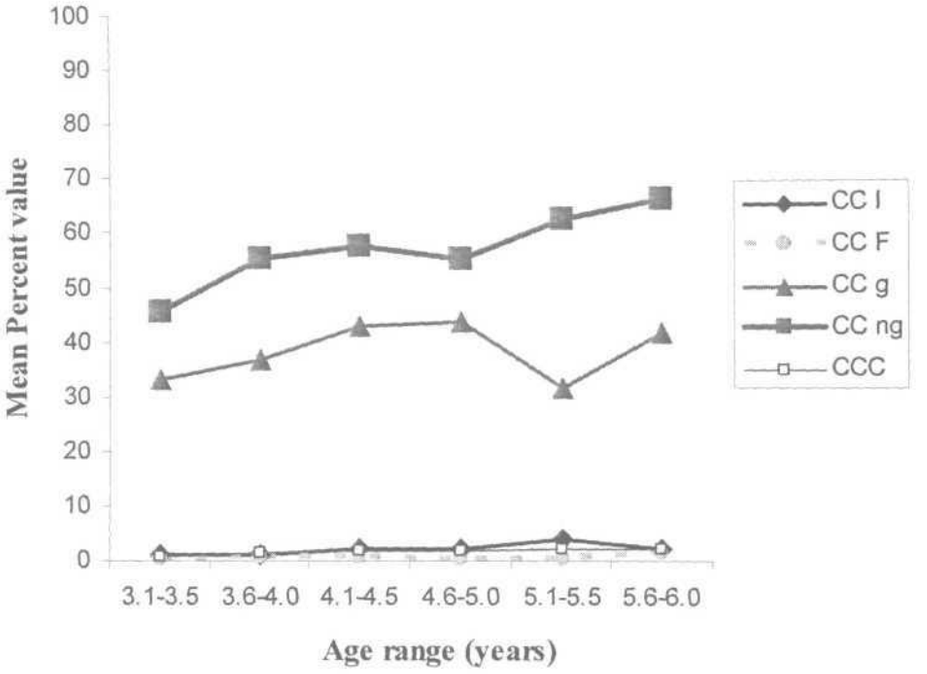
Table 5: Results of Duncan's post Hoc test for non-geminated clusters indicating pair-wise significant differences

Age group (years)	3.1-3.5	3.6-4.0	4.1-4.5	4.6-5.0	5.1-5.5	5.6-6.0
3.1-3.5		__	+	+	+	+
3.6-4.0	__		+	+	+	+
4.1-4.5	+	+		+	+	__
4.6-5.0	+	+	+		__	+
5.1-5.5	+	+	+	__		+
5.6-6.0	+	+	-	+	-	

[Note: "+" indicates presence of significant difference and "_" indicates absence of significant difference]

These results indicated that there is a gradual change in the percentage of occurrence of non-geminated clusters from 3 to 6 years of age supporting a developmental trend in the use of non-geminated clusters. The same is evident from Graph 2, where percentage of occurrence of non- geminated clusters are seem to increase from 45% in 3.1 - 3.5 year group to 55% in 5.1- 5.5 year group.

Graph 2: Mean percentage occurence of clusters



Section 3: Word shapes

When analysed for word shapes, monosyllabic, disyllabic, trisyllabic and multisyllabic words were found in the samples. Table 6 shows the percentage occurrence of various word shapes in different age groups.

From Table 6 and Graph 3, following results are evident:

- Monosyllabic words were least occurring type in the samples. Only three words within native vocabulary were monosyllabic type. These included /ma/ (our), *I'd*

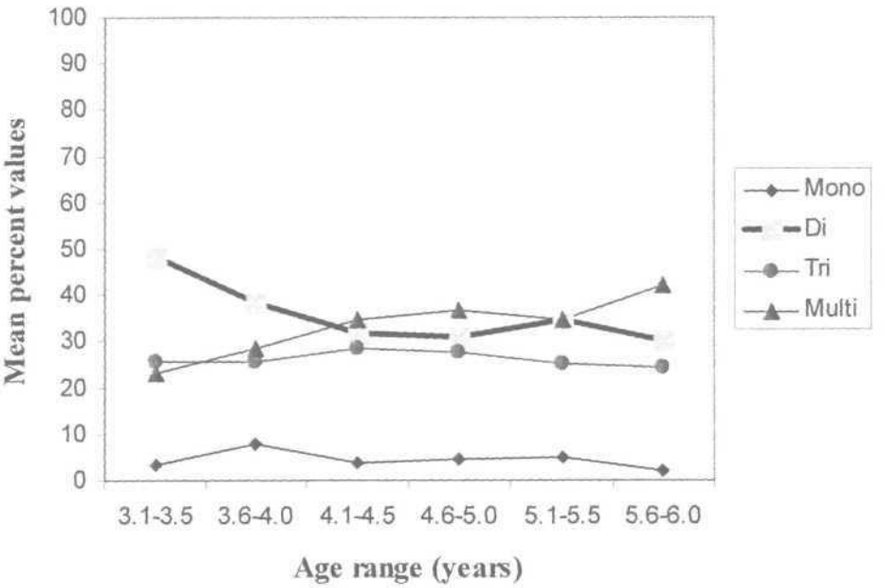
(this) and /a:/ (that). Rest of the monosyllabic words were English adopted words like 'School','class','dog'.

Table 6: Mean and standard deviation of percentage occurrence of word types

Age (Years)	Mono		Di		Tri		Multi	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3.1-3.5	3.17	1.98	50.26	14.64	25.54	7.71	23.22	23.2
3.6-4.0	7.69	3.19	38.49	6.93	25.44	5.23	28.62	28.62
4.1-4.5	3.67	4.00	31.70	6.52	28.70	4.57	34.80	34.80
4.6-5.0	4.71	4.21	30.95	9.79	27.67	8.94	36.95	36.95
5.1-5.5	5.15	2.49	34.57	6.96	25.21	5.14	34.68	34.68
5.6-6.0	2.09	2.09	30.06	8.62	24.32	7.21	42.26	42.260

- Disyllabic words were predominant in 3.1-3.5 years age group with frequency of occurrence around 50% and there after there was a gradual decrease in frequency to 30% in 5.6-6.0 years age groups.
- Trisyllabic words averaged between 25-30%, thus falling under 'occasional' category. This percentage of occurrence was maintained across age groups.
- Multisyllabic words gradually increased from 'occasional' category (23%) in 3.1-3.5 years to 'frequently' occurring category (42%) in 5.6-6.0 years. The maximum number of syllables averaged around 4-5 till 5 years and later increased to 5-6 syllables.

Graph 3: Mean percentage occurence of word shapes



To reveal interaction effects of word shape and age, one-way repeated measures of ANOVA (Mixed ANOVA) was carried out with age as independent factor. Results indicated that there is significant effect of interaction between word shape and age [F (15, 162) = 4.1; **p** < 0.05]. Further, Boniferroni's pair-wise comparison was carried out to find out pair-wise significant difference and it revealed that there is significant difference in all the pairs except in disyllabic-multisyllabic pair. When each word type was analyzed independently using one-way ANOVA, word types monosyllables [F (5, 59) = 3.86; p < 0.05], disyllables [F (5, 59) = 5.4; p < 0.05] and Multisyllables [F (5, 59) = 4.4; p < 0.05] showed significant difference across the age groups. These findings signify change in percentage values across age groups.

Section 4: Phrase-level patterns

Table 7: Examples of consonant harmony and vowel harmony in phrase-level

	Child's utterance	Target production	Meaning
Consonant harmony	/intlotinna/ /tintunna:dju/ /duddukunta/ /madjee:djto/ /tsa:n9mtse:tunna:dju/ /a:tsolov3tsa:lu/ /te:tukunta/ /duddindae/	/intlotinna/ /tintunna:dju/ /ruddukunta/ /madjeidjto/ /sna:namtse:stunna:4u/ /a:to:lovAtsae:dju/ /tse:sukun{a/ /ruddindae/	Ate at home (He is)eating (I) will rub With my father (He is) taking bath (He) came in auto (I) will do it myself As she pressed
Vowel harmony	/ikicjabettas/ /ponko:nunna:dju/ /po:vabo:sko:ni/	/ikacjabettas/ /p3nuko:nunna:dju/ /paudj3rpu:sko:ni/	I kept (it) here (He is) sleeping After applying powder

There were no instances of reduplication noticed in the samples. Consonant harmony was evident in the samples. But frequency was very less (less than 5%) upto 4 years. There after frequency of consonant harmony dropped to less than 2% of occurrence. Vowel harmony was noticed at word as well as phrase level. Percentage was maintained at around 4-5% across age groups. It should be noted that all the above

observations were made within words having more than 2 syllables. Some examples of consonant harmony and vowel harmony are listed in Table 7

Section 5: Reliability Measures

For assessing intra judge reliability, a week after completing original scoring, the investigator randomly selected 10% of total samples and repeated the procedure of transcription. Point to point intra-judge agreement was checked to look for reliability of transcription and syllabification and the results revealed a reliability index of 96%. Point to point inter-judge reliability of transcription and syllabification between experienced Speech-language pathologist and investigator revealed a reliability index of 92.4%.

The results of the study suggests that there is a developmental trend noticed in Telugu speaking children between 3 to 6 years age range in terms of phonotactic repertoire of syllable shapes, word shapes, reduplication and harmony. Percentage occurrence of syllable shapes indicated predominance of CV over CVC, VC and V types. This predominance of CV type signified that children maintained closed syllables (CV) over open syllables (CVC; C; VC), which is typically seen in adult phonology (Vasanta, 1995). This result also seems to suggest that Telugu speaking children are following universal order of syllable acquisition where CV type is reported to be acquired earlier by children of all langauges (Jacobson, 1968; Demuth, 1996). However presence of CVC averaged around 30%, followed by that of CV type. One reason for this frequent occurrence of CVC could be due to the increased frequency of occurrence of medial

clusters to a larger extent in Telugu language. When medial clusters in a word undergo syllabification, it would result in CVC syllable type. For instance syllabification of /sabbu/ (soap) as /sab/-/bu/ would result as CVC-CV pattern. There were no words ending with closed syllable types except for few words ending with nasal /m/ and few English adopted words. Absence of C type syllable indicates that Telugu language clearly follows the rule that vowel forms the syllable nucleus unlike English. Also, like in majority of the languages, Telugu allows vowel-initial syllables, which was evidenced by the presence of VC or V in the word-initial position. Both the syllable types however occurred very rarely.

Cluster analysis of the samples revealed predominance of medial clusters. Two consonant combinations (CC) showed a higher percentage of occurrence than three consonant combinations (CCC). Word-initial and word-final clusters were rare in number and all were restricted to English adopted words. Native vocabulary did not show word-initial as well as word-final clusters. The same trend follows in Telugu adult phonology except that there are few word-initial clusters (Nagammareddy, 1987). Telugu unlike English has geminate consonants in the medial position. Percentage of occurrence of medial geminated clusters was maintained at 33% on an average in 3.1-3.5 years age group and it gradually increased to 43% in 4.6-5.0 years age group. There after, there was slight reduction in the percentage till 6 years. This happened because of increase in percentage of other types of clusters. Non-geminated clusters in the medial positions had a higher percentage of occurrence of about 45-55%. There was slight increase in percentage from 45% (frequent) in 3.1-3.5 year group to 55% (predominant) in 5.1-5.5

year group. Study by Rupela & Manjula (2006) had shown similar trends in children between age ranges of 0-5 speaking Kannada language (a south Dravidian language spoken mainly in state of Karnataka). They also reported that medial geminated clusters were the first to be acquired and were the only type of clusters present in the age range of 12-18 months, remained stable as 'frequently' occurring clusters from 18-42 months and gradually decreased in frequency till 60 months. On the other hand medial non-geminated clusters appeared from 18-24 months onwards gradually increased with a trend of 'frequent' occurrence by 30-36 months, remained stable till 48 months and finally became 'predominant' by 48-60 months. High percentage of medial consonant sequences was due to the reason that majority of words in Telugu were polysyllabic, where many varieties of consonant sequences occurred at syllable boundaries. Certain medial clusters in Telugu arise due to vowel elision (Nagammareddy, 1987). E.g., /pa:lu/-/ta:ga/-/tunnardu/ [milk-drink-(he) doing] together said in a phrase would become /pa:lda:gtunna:du/ [(he is) drinking milk].

In Telugu, all the word-medial three consonant combinations contain the permitted two-consonant combinations. In the samples only the form of nasal + stop + liquid (/-ntl-/; /-ndj-/; /-ntr-/ was noticed. E.g., /intlo/ (in house); /da:ntlo / (in that) /bandlo/ (in the vehicle); /sa:jantrsmu/ (evening). However occurrence of these words is rare with a frequency of around 2%. Many other combinations in word initial and medial 3-consonant combination clusters in adult phonology are seen in Sanskrit adopted words and these are not used frequently in colloquial language. Majority of the two consonant non-geminated clusters in medial position were of the combination nasal + stop and

liquid + stop in younger age groups till 4 years. E.g., /tinʈunna:ɖu/ (he is eating); /a:ɖukunʈa/ (will play); /bɔmməlto/ (with toys); /ellɒ:jindi/ (is he went). This seemed to be a permitted combination occurring in adult phonology (Vasanta, 1995). Nirmala (1981) studied the acquisition of consonant clusters in four children between 1-4 years age range and she reported that nasal + stop consonant clusters were first to acquire among others. In this process of acquisition of clusters it was found that reduction, substitution and assimilation played a major role. Children substituted the geminate clusters for the non-geminate clusters of adult speech. Similar observations were made in the present study and the results are supporting the previous studies. E.g., /pustəkəm/→/puttəkəm/ (book); /nəɖtsi/→/nətstsi/ (by walk); /peɖta:di/→/petta:di/ (will keep).

Among word shapes, monosyllables were the least occurring and the most of them included English adopted words. This may be because of very few mono syllabic words in Telugu native vocabulary and hence it did not represent all possible structure types. In the present samples, disyllabic words were predominant in 3.1-3.5 years age group with a frequency of around 50% and there after there was a gradual decrease in frequency to 30% in 5.6-6.0 years age group. At the same time multisyllabic words gradually increased from 'occasional' appearance (23%) in 3.1-3.5 years to 'frequent' appearance (42%) in 5.6-6.0 years. The probable reason for decline in disyllabic words could be the increase in number of multisyllabic words in 5.6-6.0 years. The maximum number of syllables averaged around 4-5 till 5 years and later increased to 5-6 syllables. This is in accord with adult studies where high proportions of the words in Telugu are

reported to be polysyllabic structures (Nagammareddy, 1987). Trisyllabic words were maintained across age groups averaging between 25-30% thus falling under the 'occasional' category of occurrence of word type (Graph 3). As the age increased there was increase in frequency of occurrence of longer syllables. In Kannada language, this trend showed little deviancy where the most common type of words were disyllables, followed by trisyllables. Multisyllables increased to "occasional' status by 60 months (Rupela & Manjula, 2006).

Consonant and vowel harmony were noticed in phrase level and not within words. Examples depicted in Table 7 indicated clearly that consonant harmony was applied across words with in a phrase. Some words which children could produce correctly in single-words utterances underwent harmony in phrases. Majority of them were alveolar and palatal harmony. Typically in adult phonology, vowel harmony is seen frequently in fast tempo speech. Nominal, plural and verbal suffixes and the second verb initial syllables of compound verbs induce harmony in the first verb root (Sastry, 1984). However this occurrence of vowel harmony was 'rare' in the present samples. The reason could be that these children had not used more of such suffixes in their speech. There were no instances of word or phrase-level reduplication in the samples. In Telugu language reduplication do not signify any grammaticality unlike other languages like Warlpiri, where reduplication represents plural form. In some languages including English re-duplication may be seen in baby-talk register.

SUMMARY AND CONCLUSIONS

Every language in the world has certain set of word or syllable patterns. Language specific rules define which phones or phonetic sequences are possible in various word positions. Such rules which define the word and syllable patterns (shape and size) are called the phonotactic constraints of the language. Children implicitly learn the rules of their language including phonotactic patterns as they develop. In the present study an attempt was made to analyze some of the phonotactic patterns seen in typically developing Telugu speaking children.

The aims of the study were to establish a database on the frequency of occurrence of the following in the speech of children speaking native coastal Telugu dialect in the age range of 3 to 6 years.

a) Syllable (CV, VC, CVC, V and C) and word shapes (monosyllabic, disyllabic, trisyllabic and multisyllabic)

b) Position of clusters (initial, medial, final) and types of Clusters (-CC-, -CCC-, geminated and non- geminated clusters)

c) Word and phrase-level patterns like harmonized vowels, harmonized consonants and reduplicated syllables

Sixty normal children speaking south coastal Telugu dialect between age ranges of 3-6 years were included. Equal number of males and females were included and they were divided into six groups with an age interval of six months, as 3.1-3.5 years, 3.6- 4.0

years, 4.1-4.5 years, 4.6-5.0 years, 5.1-5.5 years, and 5.6-6.0 years. 10 children were included in each group. Conversational speech samples were obtained from all the subjects in a natural setting using a digital recorder. 100-word sample from each subject was selected and were transcribed using IPA by the investigator. Transcribed samples were syllabified for the further analysis. For the calculation of percentage of occurrence of various syllable structures (syllable shapes, word shapes and clusters in all positions) and word-level patterns (harmony, reduplication), the formulae given by Velleman (1998) were used. Intra and inter judge reliability were also carried out to check the reliability of transcription and syllabification.

Syllable shapes found were CV, CVC, VC and V. Across 6 groups CV (around 60%) was predominant followed by CVC (around 30%). VC and V types fell under 'rare' category with less than 10%. Cluster analysis revealed that medial 2-consonant clusters were predominant compared to other types. With-in medial clusters, non-geminated clusters have higher percentage of occurrence of about 45-55% compared to geminated clusters. Initial, final and medial 3-consonant clusters occurred in 'rarer' and frequency of occurrence was very less. Nasal + homorganic stops *(/nt/,* /nd/, /nk/, /mt/ etc) clusters were predominantly noticed in the samples followed by fricatives + plosive combination (-st-) clusters. Three consonant clusters occurred medially with combination of nasal + stop + liquid combination (-ntl-).

Among word shapes disyllables were predominant followed by multisyllabic words. As the age increased, disyllabic words reduced in frequency and multisyllabic

words increased in frequency. Monosyllabic words were the least occurring ones. Trisyllabic words averaged around 30% then falling under 'occasional' category.

Words and phrase-level reduplication were totally absent in the samples. However consonant harmony and vowel harmony were noticed less than 5% of occurrence till 4 years of age. Frequency of occurrence of such patterns decreased with age. Intra and inter judge reliability showed good correlation between experienced speech language pathologist and investigators' transcription and syllabification of the samples.

Future directions:

- Study can be planned with wide range of age to examine the exact age of onset of phonotactic patterns.
- Metrical stress analysis can be investigated to differentiate between easy and difficult patterns and also to see if there is any developmental pattern of acquisition in children.
- More detailed analysis on interaction between Phonetic and phonotactic development is required in formulating comprehensive assessment tools.

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APPENDIX

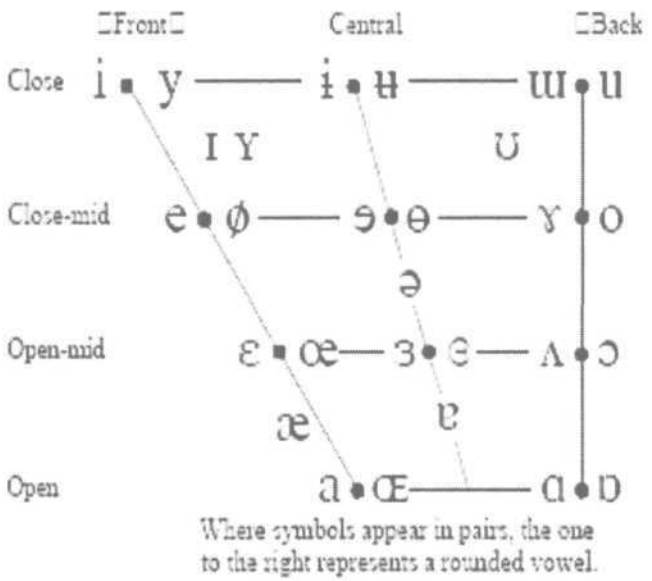
THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	B			r					R		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

VOWELS



Where symbols appear in pairs, the one to the right represents a rounded vowel.