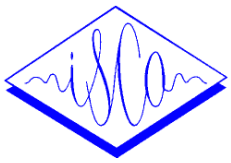

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PHONETIC, PHONOLOGICAL, MORPHO-SYNTACTIC AND SEMANTIC FUNCTONS OF SEGMENTAL DURATION IN SPOKEN TELUGU: ACOUSTIC EVIDENCE

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Abstract

This paper examines different aspects of the duration of Telugu speech sounds at both word level and sentence level, which is not only effective in contributing towards a better understanding of the spoken language, but is also essential for theoretical, practical and clinical applications. Telugu has multidimensional organization of segmental duration. It has various contrastive functions of duration at different levels of linguistic signal. There is a contrastive duration both in vowels and consonants at the phonological segmental level and the duration also combines with other higher level structures to bring out the difference in meaning. The intrinsic duration of segments also varies depending upon the (sound) type, position in the utterance, surrounding phonetic context, number of syllables in a word and so forth. Variations in duration of the segments have been correlated with phonetic, phonological, syllable, word, morphological, syntactic, semantic, pragmatic and some other levels of speech.

I. INTRODUCTORY REMARKS

Duration is one of the most important aspects of speech which functions in Telugu both as a segmental and suprasegmental feature. There have been several studies on duration (timing) of speech sounds, but mostly of European languages, devoted to the discussion and explanation of patterns of duration of speech sounds and their perceptual importance in the identification of linguistic units. Many scholars are of the opinion that the systematic features of the speech waveform down to the finest details are essential to solve the problems of speech synthesis [13]. Yet, there is very little quantitative data available on changes in segmental durations of speech with regard to particularly Indian languages.

The length of sound units, syllables, words, phrases and sentences (in the sense of the time spent over on them) are all variable and such variables are used for linguistic purposes. Hence a priliminary investigation is made into the phonetic and linguistic uses of segmental duration in Telugu. The study of Telugu language is interesting as it makes use of **phonologically distinctive length** at the segmental level and at the higher levels of syllables and across words (e.g. /akka ba:wa/ 'sister's brother-in-law' vs. /akka: ba:wa/ 'sister and brother-in-law') and **phonetically conditioned variation in duration** of the segments due to (a) **positional effects** (e.g. final vs. non-final, (b) **contextual effects** (e.g. post-vocalic consonant voicing, aspiration, length etc.), and (c) **structural effects** (e.g. mono- vs. polysyllable).

There are both top-down effects and bottom-up effects. Length in spoken Telugu is a multifaceted phenomenon, highly structured, independent, but interdependent in its subcomponents. The segmental duration is dependent both on inherent properties of the concerned sound units and a number of linguistic positional constraints imposed contextually. Due to constraint of space, each function or factors of duration in Telugu is considered as briefly as possible. The following sections will deal with the phonemic inventory and phonotactic (structural distributional) constraints which forms the basis for the study of segments. Then the significance of duration at various levels of linguistic analysis and the related semantic and pragmatic dimensions where applicable is discussed with suitable examples.

II. PHONOLOGICAL INVENTORY AND PHONETACTICS

There are slightly different (coexistent) phonemic systems of Telugu [1]. However, there are ten basic vowel phonemes: i/i:, e/e:, u/u:, o/o:, and a/a:, two diphthongs: ai and au, and thirty three consonant phonemes: p, p^h, b, b^h ; t, t^h, d, d^h ; ṭ, $ṭ^h$, ḍ, $ḍ^h$; k, k^h, g, g^h ; c, c^h, j, j^h ; m, n, ṇ ; f, s, ṣ, š, h ; l, ḷ, r, w and y. All vowels and diphthongs, except /o/, occur in all positions of a word. The occurrence of long vowels and the diphthongs is restricted [2]. Consonants do not normally occur word finally in native words of Telugu [3]. The distributional restrictions and the possible consonant clusters in Telugu can be found in [4].

Distinctive length: Five pairs of vowels are distinguished according to length. To cite an example, /a/ in /padi/ 'ten' and /a:/ in /pa:di/ 'partition'. All consonants, except the aspirated and the fricatives f, s, š and h, can also contrast in length in such examples as /n/ in /mona/ 'the tip' and /nn/ in /monna/ 'day before yesterday'. The consonants are phonetically long but treated phonologically as geminates in Telugu as they occur across the syllables in a word.

III. SUBJECTS, DATA, AND ACOUSTIC MEASUREMENTS

Three adult male educated speakers of Telugu served as subjects. The material consisted of sets of isolated words, phrases and sentences [2,5,1,6]. The acoustic measurements of duration of speech units were made from spectrograms.

IV. USE OF SEGMENTAL DURATION AT VARIOUS LEVELS

1. Extralinguistic level

Increase in speaking rate is accompanied by shortening of segments of non-initial syllables much more than the initials.

2. Discourse level

Semantic and pragmatic implications involve the use of duration in such examples as /andaru: ra:le:du/ 'not all people came' implies /kondaru vacca:ru/ 'some people came'. The forms like /anni:/ 'all (objects)' or /anta:/ 'all (quantity)' are also used in the same way as /andaru:/ . These forms without the final length give different meanings.

3. Semantic level

Telugu makes use of length as emphatic marker in such examples as /pe:dda/ 'very big' vs. /pedda/ 'big'. The forms like /evarinadigina cepta:ru/ 'from whom can (one) know' vs. /evarinadina: cepta:ru/ 'anybody can tell' differ only in the use of length as semantic marker.

4. Morphological and syntactic levels

The word final vowel length in modern Telugu is, historically, derived from a morpheme with a complex semantic structure [7,8].

The following are some of the functions of vowel duration at morphological and syntactic levels.

(a)Additive or accompaniment ('also'): The final vowel of a nominal is lengthened to indicate that the referent of the nominal is also involved, affected, participated, or has undergone the action denoted by the verb. Observe (a) and (b) instances below:

(1a) /ra:mayya polamu konna:ḍu/ 'Ramayya bought (a piece) of land' vs (1b) /ra:mayya: polamu konna:ḍu/ 'Ramayya also bought (a piece of) land

(2a) /atanu re:pu wasta:ḍu/ 'He will come tomorrow' vs. (2b) /atanu re:pu: wasta:ḍu/ 'He will come tomorrow also'

The pragmatic/semantic implementation of the (b) instances reveals that the lengthened nominals are involved in the action besides (unspecified) others.

(b) Phrasal conjunction or coordination ('and'): A nominal (phrasal) conjunction in Telugu is formed by lengthening the final vowel of each of the conjunct nominals, irrespective of the number of nouns involved in a construction. The nominals may be standing for any of the syntactic functions of Subject, Direct object, Indirect object, or Oblique objects like locative, goal and others. For example,

/si:ta: padmini: ra:mu: baḍiki waccina:ru/ 'Sita, Padmini and Ramu came to the school'

These constructions which occur with final long vowel would occur without the length in isolation.

(c) Copulative compounds or lexical doublets: This type of coordinative or copulative compounds consists of two lexical items both referring to a certain semantic field, and belonging to the same parts of speech. The mechanism of lengthening final vowel of both the items serves the function of such formations as for instance, /re:yi: pagalu/ 'Night and day'. Here word final length carries the function of a conjunctor.

(d) Disjunctive with negative constructions: For example, /si:ta: ra:le:du padmini: ra:le:du/ 'Neither Sita nor Padmini came'.

(e) Negative concessive: For example, /pilicina: palakaḍu/ 'Even if (one) is called he won't respond'

(f) Set exhaustion, totalising or summing with numerals and quantifiers: (i) **Quantifier:** Examples- /andaru/ 'that many people' vs. /andaru:/ 'all the people', /anni/ 'that many (objects)', vs. /anni:/ 'all (the objects)' /anta/ 'that much (quantity)' vs. /anta:/ 'the entire or all'. **(ii) Numerals and Numeral phrases:** Lengthened numeral indicates that all that was expected has been fulfilled or it implies that the entire activity is completed or carried out. For example, /naluguru vacca:ru/ 'Four people came' vs. /naluguru: vacca:ru/ 'All the four have come'.

(g) Negative interrogative constructions: The final vowel length of an interrogative pronoun indicates the meanings of none, nothing, never, seldom, etc. For example, /evaru tinale:du/ 'who has n't eaten ?' vs. /evaru: tinale:du/ 'Nobody ate'.

(h) Vocative or calling attention: These forms always make use of prolongation of the word final vowel. For example, /si:ta:/ calling a person by the name Sita

(i) Either-or function: Duration of the vowel is used in such constructions as /aḍigina: prayo:janam le:du/ 'it won't help even if you ask'.

(j) Echo formation: In examples such as /puli: gili:/ 'tiger and something like that where /puli/ 'tiger' occurs with a short vowel.

(k) Reduplication: Segmental length is used in reduplication in examples such as, /tini: tinaka/ 'not eating properly'.

Prepausal lengthening occurs at phrase and clause boundaries as in English. In Telugu, word final lengthening occurs when the words are in isolation, but are reduced when the same words occur in sentences.

Contrary to English [9] subject position in a simple sentence is lengthened more when preceded by an adjective than when noun appears by itself. For example, /raitulu naṣṭapo:ta:ru/ 'farmers (will) loose' /bi:daraitulu naṣṭapo:ta:ru/ 'poor farmers (will) loose'. An example of length functioning as a syntactic marker is in /evaru ra:le:du/ 'who has not come' vs /evaru: ra:le:du/ 'no one has come'.

5. Word level

A vowel is lengthened in a word final position than in a word initial position, which in turn is longer than in word medial position. For example, /a/ in /alaka/. Word final segments are lengthened to such an extent that the duration of the short vowel may be same as the duration of the long vowel leading to some kind of neutralization of length distinction between short and long vowels. This doesnot seem to be the case with long vowels. For example, the second /a:/ in /ca:la:/ 'too much' where the long final vowel is not lengthened.

6. Duration as boundary signal

In examples such as /a:ka:ram/ 'shape' vs. /a: ka:ram/ 'that hot chilly', it is the duration that mainly functions as the most significant boundary (i.e., junctural) marker between /a:/ and /k/.The duration of the initial /a:/ in the first instance is much shorter than the same /a:/ in the second instance. Duration of the vowel can also be used to signal the presence of phrase and sentence boundaries in Telugu. The last syllable of a word, phrase, clause or sentence are produced with a greater duration than the same syllables in non-final position of the utterances. An interesting behaviour of duration of preboundary lengthening is that the word-final segment is longer than the phrase-final, and phrase-final (the short vowel being 160 ms. and the long vowel 200 ms.) is longer than the sentence-final segment (which is about 80 ms. long only).

7. Intrinsic phonetic/phonological duration

The details of various factors of duration of vowels and consonants in isolated words as well as in connected speech can be found in [2,5,6,10,11]. The durational effects at this level seem to be: (1) **Positional effects** where word finals are much greater than the non- final segments. Non-final segments are also influenced by the syllable weight or boundary in that the vowels in open syllables tend to be longer than the same vowels in closed syllables. (2) **Contextual coarticulatory effects**, where the duration of the vowel changes depending upon the consonant type that follows it. Consonant voicing, aspiration, length, place, manner etc. have effect on the duration of the following/preceeding vowel. The consonantal sequences have a shortening effect on the preceeding vowel which is the case with long consonants and also aspirated consonants. The duration of diphthongs is the same as that of long vowels. Long vowels and consonants have 1.5 to 3 times the duration of corresponding short ones. The consonants grouped into classes show the following order of there relative decrease in duration: aspirated stop > affricate > voiceless plosive > fricative > semivowel > voiced plosive > nasal > lateral > trill. The nasal followed by a voiced plosive is considerably longer (which is not so much noticed for the vowel) than the same nasal followed by a voiceless plosive. The duration of the intervocalic closure is greater in voiceless than in voiced plosive and also greater for aspirated than for unaspirated (see Fig.1). There is an interaction of phonation type and vowel duration in Telugu as in Kharia and Hindi [11]. The vowel is found to be shortest before voiceless aspirated and longest before voiced unaspirated. (3) **Structural effects** where Only long vowels occur in monosyllbles. All vowels, short or long, have a tendency to be reduced in polysyllables. There is tendency for all types of segments to be shorter when the number of syllables and segments in a word is increased. All vowels are longer in open syllables than in closed syllables. The difference found in vowels in this context is larger than the difference found in vowels before voiced and voiceless consonants. Consonants in sequences tend to be lengthened, except the post-nasal voiced plosive which tends to be reduced after the nasal than in isolation. The phenomenon of consonants being lengthened (rather than shortened) in sequences than in isolation is quite contrary to English [9,11,14].

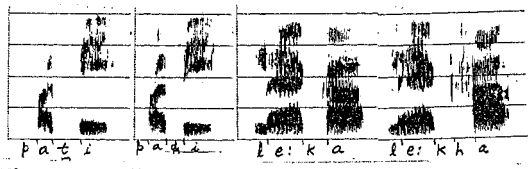

Fig.1 Broadband spectrograms are shown of two phonemic contrasts in which segmental duration is strikingly marked. The voiced plosive /d/ in /padi/ 'ten' is inherently shorter than the voiceless /t/ in /pati/ 'husband' and the aspirated plosive /k^h/ in /lek^{h}a/ 'letter' is inherently longer than the unaspirated plosive /k/ in /le:ka/ 'without having'.

V. CONCLUSION

The goal of this paper is to provide a list of possible durational effects that exist at various levels of linguistic structure in Telugu. The results indicate that the timing process operates atleast at three different levels: **(1)** at the level of sentence, phrase, word, and syllable, where it is related to the boundary phenomena represented by final lengthening, **(2)** at the phonological level as contriastive duration in both vowels and consonants, and **(3)** at the segmental phonetic level to accommodate positional and contextual effects. The contribution of duration as a cue to stress, pitch, juncture in such examples as /pilli pilla/ 'kitten' and /pilli:pilla/ 'cat and young one' is also notable though there is a slight accompanying quality and pitch difference in the phrases compared.

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References

[1] K. Nagamma Reddy, "Social and regional varieties of Telugu: Problems and Prospects of Education Development," XV Indian Social Congress, Berhampur University, Orissa, 1990.

[2] K. Nagamma Reddy, "An Instrumental Phonetic Study of Long and Short Vowels in Telugu," Proc. XIII All India Conference of Linguistics," Poona, pp.127-148, 1986.

[3] K. Nagamma Reddy, "Syllable and Word Structure in Telugu," Studies in Telugu Language, Telugu University, Hydrabad, pp.52- 70, 1987.

[4] K. Nagamma Reddy, "Consonant Combinations in Telugu," Work in Progress, University of Edinburgh, Vo.12, pp.79-99, 1980.

[5] K. Nagamma Reddy, "The Duration of Telugu Speech Sounds: An Acoustic Study," J. Institution of Electronics and Telecommunication Engineers, Vo.34, No.1, pp.36-57, 1988a.

[6] K. Nagamma Reddy, "Acoustic Correlates of Voicing in Tamil and Telugu," J. Dravidic Studies, Vo. 2, No. 1, pp.29-52, 1992a.

[7] K. Mahadeva Sastri, Historical Grammar of Telugu, S. V. University P. G. Centre, Ananthapur, 1969.

[8] M. B. Emeneau, "The Indian linguistic area revisited," IJDL, Vo. 3, pp.92-134, 1974.

[9] D. H. Klatt, "Linguistic Uses of Segmental Duration in English: Acoustic and Perceptual Evidence," J. Acoust. Soc. Amer., Vo.59, pp.1208-1221, 1976.

[10] K. Nagamma Reddy, "Towards a Reanalysis of Aspirated Consonants," Proc. XV All India Conference on Linguistics, Pune, pp.29-42, 1988b.

[11] K. Nagamma Reddy, "Lengthening of Consonants in Sequences: Evidence for Syllable Division in Telugu," 21st All Indian conference of Dravidian Linguists, International School of Dravidian Linguists and Indian Institute of Dravidian Studies, Kuppam, 1993.

[12] K. Nagamma Reddy, "Interaction of Phonation Type and Vowel Duration: The Case of Certain Indian Languages," Workshop on Speech Technology, Department of Computer Science and Engineering, Indian Institute of Technology, Madras, pp.62-77, 1992b.

[13] I. Lehiste, "Linguistic Aspects of Time Dimension of the Acoustic Signal," J. Acoust. Soc. India, 1988.

[14] L. Lisker, "On Time and Timing in Speech," Current Trends in Linguistics, Vo.12, pp.2388-2418, 1974.