PHONOLOGICAL MEAN LENGTH OF UTTERANCE (PMLU) IN TYPICALLY DEVELOPING TELUGU SPEAKING CHILDREN: A DEVELOPMENTAL PERSPECTIVE

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Abstract

Phonological MLU or pMLU is a measure of whole word complexity that gives an indicator of phonological development. The objective of the current study was to study phonological skills of Telugu speaking typically developing children using pMLU as a measure. Cross-sectional data were collected from fifty typically developing Telugu-speaking children. Children were divided into five age groups from 2;6 to 5;0 years of age. As age increased, the pMLU also increased and the five age groups were significantly different from each other. Overall, the pMLUs were larger than those of English- and Hindi- speaking children and similar to those of Kannada-speaking children. Further, pMLUs of five mental age matched children with Down syndrome are presented in comparison to those obtained from typically developing children. Children with Down syndrome demonstrated pMLUs which were significantly lower than those of the typically developing children. Results are discussed from a cross-linguistic perspective highlighting the limitations and usefulness of pMLU in the Indian context.

Keywords: *pMLU, phonology, Telugu, Down syndrome*

Early studies on phonological acquisition have emphasized analysis of individual segments in within a word or utterance in general and specifically the accuracy of consonants. Quantification of errors has had some focus as well. One popularly used metric is Percentage of Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982; Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997) and many variants have also been described in the literature considered to be useful for varied clinical or research purposes. However, types of errors and whole-word errors are not taken into account. Recent studies have focused on measures of whole word complexity (Masterson & Kamhi, 1992, Ingram, 2002). One such whole word measure targeting phonological proficiency is the Index of Phonetic Complexity (IPC; Jakielski, 1998) designed to capture the nature of child's speech independent of the target in terms of features (dorsals, liquids, affricates), word characteristics in terms of place of articulation and word shapes (final consonants and clusters). This has the advantage of analyzing the strengths and weaknesses of the child's phonological system rather than simply comparing the child's phonological system with a target. However, not much psychometric data is available for this measure and three is a need for further studies on establishing validity and reliability for the IPC measure.

Another measure, the Weighted Speech Sound Accuracy (WSSA; Preston, Ramsdell, Oller, Edwards, & Tobin, 2011) on the other hand uses a relational analysis (i.e. comparing the child's form with the adult target). Child's production is compared with the target form in terms of the number of segments (global structural agreement) and in terms of features of the segments that are represented (featural agreement) to result in a single score for a given utterance, segment or sample (Preston, et al., 2011). Weightage is given according to the kinds of errors recorded. Major changes in substitution as judged in English are weighted more heavily than minor changes. Initial validity and reliability data do point to usefulness of this measure in separating typical and disordered speech production. More research will prove valuable in establishing a quantification system for phonetic accuracy.

Another measure is the Phonological Mean Length of Utterance (pMLU) (Ingram & Ingram, 2001; Ingram, 2002) which has gained popularity despite its limitations in not giving weightage to types of errors which have been overcome by measures such as IPC and WSSA. pMLU is calculated as the total number of consonants and vowels produced regardless of whether they are accurate or inaccurate plus the number of correct consonants, divided by the number of words produced (Ingram, 2002). The value of pMLU has been demonstrated in tracking phonological development in monolinguals, bilinguals, across languages, and in comparison with children having disordered phonologies. It must be noted that the pMLU measure may be influenced by the

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phonological structure of words and child's vocabulary (Preston, et al., 2011). This measure has had a lot of attention in India as well with studies being published in Kannada, and Hindi in typically developing as well as disordered population.

Two studies have been done in Kannada-speaking children. Balasubramanium and Bhat (2009) investigated pMLU in 400 Kannada-speaking children between 3-7 years of age. pMLU from spontaneous speech samples increased with increase in age of children indicating a developmental trend in pMLU acquisition. No significant gender differences were observed. Archana, John, Veena, Mohite and Rajashekhar (2011) studied Kannada speaking children with Down syndrome between 6 to 15 years and language-age matched typically developing children (3-4 year olds'). Children with Down syndrome (DS) had significantly lower pMLU scores when compared with typically developing children. All of the typically developing children belonged to stage V and above of pMLU as described by Ingram (2002). On the other hand, 57% of the children with DS were in group V, around 3% were in group III, 34% were in group IV, and 6% belonged above group V. A comparison of the two studies in Kannada was not possible because of unavailability of raw scores. Findings were only reported to be slightly different because of variations in method in the two studies including nature or speech sample, sample size and listener bias. pMLU and related measures (Percentage of Words Correct-PWC and Proportion of Whole Word Proximity-PWP) were studied in Hindi among12 typically developing children in the age range of 2-3 years divided into two groups of six-month age intervals (Jaisinghani, Akshay, & Sreedevi, 2012). The study utilized 30 'most familiar' words from the Hindi articulation test to obtain the speech samples. While there was a significant increase in scores of pMLU and PWP in the older children, PWC scores in the younger and older groups were not significantly different from each other. Authors report that their results were 'similar' to those found by Balasubramanium and Bhat (2009). Since the age ranges of the Hindi study (2-3 years)were different from the Balasubramanium and Bhat study (3-6 years), we presume the authors mean similarity in terms of age effect i.e. pMLU values increase with age. Also, there were methodological differences between the two studies and therefore no direct comparisons can be made. While Balasubramanium and Bhat (2009) used spontaneous speech samples, the other two Indian studies (Archana et al., 2011; Jaisinghani et al., 2012) used imitation tasks involving repetition of

words from articulation tests. In another study, Balasubramanium, Bhat, and Prasad (2011) studied 16 individuals with phonological disorders between 3 and 6 years of age in comparison with 30 chronological age matched typically developing children. They found that pMLU of children with phonological disorders were significantly lower than those of typically developing children.

Ingram (2002) studied children acquiring Cantonese and Spanish in a cross-linguistic study. It was found that while the Cantonese child had relatively low pMLU, the Spanish children, had higher pMLU values by the age of two years. Ingram (2008) made a cross-linguistic comparison of Spanish, English, French and Dutch. While the Spanish speaking children had relatively low pMLU values, English, French and Dutch-speaking children had relatively low pMLU values suggesting that the phonologies of these languages are harder to acquire (Ingram, 2008). pMLU was therefore found useful in discerning cross-linguistic differences and also helped in understanding the course of phonological acquisition in varied language environments.

Utility of pMLU also lies in studying children with communication disorders. Gerrits and Bree (2009) studied PCC (Percentages of Consonants Correct) and pMLU in Dutch children with a family history and therefore risk of dyslexia and compared the results with children with Specific Language Impairment (SLI) and typically developing children. Lowest scores were obtained by children with SLI, followed by children at risk of dyslexia, and typically developing children. pMLU values and PCC scores were examined in Spanish-English bilingual children with speech sound disorders and age-matched monolingual peers (Burrows & Goldstein, 2010). Results revealed that differences between the bilingual children with speech sound disorders and monolingual children were not statistically significant. In a study of Finnish children with developmental verbal dyspraxia, Martikainen and Korpilahti (2011) examined the efficacy of Touch-Cue Method and Melodic Intonation Therapy, using the pMLU measure among other measures. They found that the child's progression during the period examined was meaningfully reflected in the pMLU values.

There exist very few studies on phonological development in children speaking Indian languages which have examined the pMLU measure. This measure seems to have had some popularity in India in the recent past and we decided to study its usefulness in the data in Telugu speaking children. The current study

aimed to determine the pMLU in utterances of typically developing Telugu speaking children between 2 years 6 months and 5 years of age. A group of five children with Down syndrome were also included in a comparison group to evaluate the clinical utility of this measure.

Method

Participants

Standard group: Fifty typically developing children in the age range of 2; 6 to 5; 0 years participated in the study. Children were enrolled from play schools, pre-primary and primary schools in Hyderabad, Andhra Pradesh. They were divided cross-sectionally into five groups of six-month age intervals (group-1: 2;6-3;0 & group-5: 4;6-5;0 years). Each group had an equal number of male and female participants. All children were from primarily Telugu speaking families and they had limited exposure to Dakhini and English in their respective schools and neighborhoods. Inclusionary criteria for enrolment of children into the study included typical development of speech and language as reported by parents and age appropriate performance on Receptive and Expressive Emergent Language Scale (REELS; Bzoch& League, 1971) and the extended Receptive and Expressive Emergent Language Scale (compiled by All India Institute of Speech & Hearing),no prior enrolment in speech or language intervention and learning difficulties as per teacher's reports, normal hearing status as per informal hearing screening, and without developmental, psychological or neurological deficits. The structure and function of oral articulators was found to be within normal limits as assessed informally.

Comparison group: Five children with Down syndrome with a mental age of 3 to 5 years and chronological age between 5-8 years were also included in the study. Of the five children, four were females and one child was male. All children were reported to have Trisomy 21 by their caregivers. They had all been receiving speech and language therapy for an average of 2 years. Details of receptive and expressive language ages are given in Table 2. Their recordings were conducted in relatively quiet surroundings using a digital recorder

Stimuli: In order to assess the pMLU, spontaneous speech samples were elicited from each child for duration of 20 to 30 minutes. Samples comprised a minimum of 50 utterances.

Procedure

The experimenter served as a conversational partner and elicited a spontaneous speech sample from children using age appropriate pictures and toys. 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). Conversational speech is also considered to reflect the child's habitual speech in actual communicative settings (Craighead, Newman & Secord, 1989). The samples were obtained informally and audio recordings were done using a portable digital recorder in a relatively quiet environment. The children's productions were transcribed using broad IPA transcription method and pMLU was calculated for each child as per the guidelines given by Ingram (2002). For each word, the number of consonants and vowels as produced by the child were counted and summed with the number of correct consonants in the word. This sum calculated for each word was further summed across all the words produced by a child and divided by total number of words to obtain the pMLU scores.

In the pMLU count, the child's target words were first assigned points for all segments (one point for each consonant and vowel segment) and an additional point wasgiven for all consonants (one point per consonant). A Telugu word such as /ka:lu/, meaning'leg', would receive a score of six (four plus two), while a word such as /padava/, meaning'boat', would receive a score of nine (six plus three). Therefore, in an analysis of 50 words, all 50 target word pMLU scores were added and the sum was divided by 50 to gain an average pMLU score for a child.

Statistical Analysis: One-way Analysis of Variance (ANOVA) was used to assess differences in pMLU across the five age groups among typically developing children. Paired comparisons between age groups were made using Bonferroni post-hoc analysis. Five children with Down syndrome were also included in a comparison group. However, no group comparisons between typically developing children and children with Down syndrome were made because of the small number of children in the comparison group. It was found more useful to compare the individual findings of this group because of the variability in speech of children with Down syndrome (Stoel-Gammon, 1980).

Results

pMLU in typically developing children : Table 1 shows the descriptive statistics for pMLU calculated for conversational speech samples of typically developing children in the five age groups. The same is shown in Figure 1. Groups 1 through 5 represent the younger to older children. Statistical analysis was done using One-way ANOVA that revealed significant differences in pMLU of children across the five age groups (F $(4, 45)$ = 412.53, p<0.001, η^2_p = 0.973) suggesting a developmental trend in the pMLU scores of Telugu-speaking children from 2; 6 years to 5 years of age. Post hoc analysis of age effect using Bonferroni method corrected for multiple comparisons revealed significant differences across the five age groups (p<0.001). Therefore, pMLU scores increased across all the five age groups of children. If we were to divide the groups in terms of stages as described by Ingram (2002), we would find that while group 1 and 2 were in stage V, the other three groups were above stage V. Therefore, even though the group means were increasing with age, the progression of 'stages' did not occur the same way.

Table 1: .Descriptive statistics for pMLU among the five age groups of typically developing children

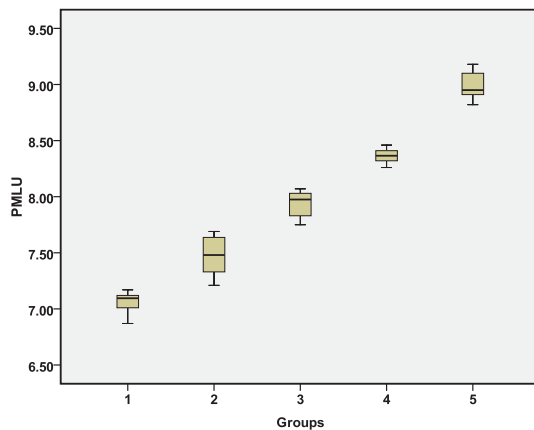| Age Groups (years; months)	Mean	SD	Median	Minimum	Maximum
2; 6 - 3; 0	7.06	0.10	7.10	6.87	7.17
3;1 - 3;5	7.48	0.17	7.48	7.21	7.69
3; 6 - 4;0	7.95	0.11	7.98	7.75	8.07
4;1 - 4;5	8.36	0.07	8.37	8.26	8.46
4; 6 - 5; 0	8.99	0.12	8.95	8.82	9.18
Total	7.97	0.69	7.98	6.87	9.18

Figure 1: pMLU for five age groups of typically developing children

Comparison of pMLU by gender showed that there was no statistically significant difference between the means of pMLU scores of female and male participants across the different age groups.

pMLU in children with Down syndrome : Five children with Down syndrome (DS) with a mental age between 3-5 years were also included in the study in order to investigate the clinical utility of the pMLU measure. The chronological age of children ranged from 5-to-8 years. Table 2 shows the pMLU obtained from conversational speech samples of children with Down syndrome.

Table 2: pMLU in children with Down syndrome

Sr. No	Chrono-logical Age (years; months)	Sex	Receptive Language Age (years; months)	Expressive Language Age (years; months)	pMLU	Stage of pMLU
1	5;0	F	3;6 - 4;0	3;0 - 3;6	7.61	Above V
2	5;5	F	2;9 - 3;0 scattered to 3;0 - 3;6	2;6 - 2;9 scattered to 2;9 - 3;0	6.16	IV
3	5;7	F	2;9 - 3;0 scattered to 3;0 - 3;6	2;6 - 2;9 scattered to 2;9 - 3;0	5.77	IV
4	8;0	F	3;6 - 4;0 scattered to 4;0 - 4;6	3;0 - 3;6	7.67	Above V
5	7;0	M	3;0 - 3;6	3;6 - 4;0	7.58	Above V

The pMLU scores of children with Down syndrome ranged from 5.77 to 7.67. While two children were in stage IV, the other three were above Stage V. Since there were only five children in the comparison group, we found it more useful to compare their individual means to the typically developing children's group means rather than the stages they were in. pMLUs that were lower than those seen in typically developing children below 3 years 6 months of age. Indeed, the language age of children with Down's syndrome was lower than age matched typically developing children.

Discussion and Conclusions

The current study attempted to investigate pMLU in typically developing Telugu speaking children of 2;6-5;0 years of age. Clinical utility of calculation of pMLU scores was also investigated on children with Down syndrome. Results revealed that among typically developing children, pMLU scores increased with age and the differences were significant across the multiple comparisons. pMLU seems to be a fairly good indicator of phonological maturity with age

among typically developing children. When we compared 5-8 year old children with Down syndrome, we found that their scores were lower than those seen in typically developing children below 3;6 years of age. The results suggest that phonological patterns used by children with Down syndrome have characteristics of those used by typically developing younger than 3;6 years.

In general, the pMLU scores were higher in comparison to those of English speaking children as reported by Ingram (2002) and largely similar to those observed by earlier studies of Kannada speaking typically developing children (Balasubramanium & Bhat, 2009; Archana et al., 2011). Kannada and Telugu are both Dravidian languages that are phonologically similar to each other. On the other hand, English has a different morphosyntactic and phonotactic structure when compared to Dravidian languages. The stages described by Ingram (2002) could not be suitably applied in the current context. In typically developing children, while the means increased with age, the stages did not and therefore, it was not useful in the present study to compare the stages in and of themselves. In fact, in children with Down syndrome, the children above stage V were only around 0.08 to 0.11 points above the cutoff point for being in Stage V. It is therefore clear, that the same cut-off points for pMLU in English-speaking children cannot be applied for children speaking Dravidian languages such as Kannada or Telugu. However, pMLU was useful in both deriving a developmental trend in phonology among typically developing children and also in its clinical value for the assessment of phonological skills of children with Down syndrome. Significant differences in pMLU were observed across the groups of typically developing children in the current study. These preliminary findings among children with Down syndrome suggest that pMLU has potential to serve as indicator of phonological complexity of a child's speech. It is also clear that chronological age of children with Down syndrome was not an indicator of pMLU.

In conclusion, most of these numerical measures of phonology such as PCC (Shriberg & Kwiatkowski, 1982; Shriberg et al., 1997) and all its variations, pMLU, IPC (Jakielski, 1998), WSSA (Preston et al., 2011)and other such measures of phonological complexity may be appropriate as objective measures especially for research purposes. Their value in the clinical setting for deriving phonological goals for intervention however needs careful consideration. Nevertheless, such measures require rigorous psychometric data in order to be applicable to the Indian context. A beginning was the study using

400 spontaneous speech samples by Balasubramanium and Bhat (2009). However, the validity and reliability of the measure could not be established and unavailability of raw scores made the task of cross-linguistic comparisons difficult. Various limitations of pMLU need to be evaluated before such a large scale study is implemented. The findings of the current study in Telugu are preliminary. Future studies using large samples and rigorous psychometric data would go a long way in rendering usefulness of a measure such as pMLU in the Indian setting.

Acknowledgment

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