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Measuring the Whole Word Complexity in Tulu Speaking Children between 3 to 4 Years of Age

Anuradha Shastry, BASLP, Shruthi Nayak, MASLP, Veena K.D., Ph.D.
and Sunila John, MASLP

Abstract

The utility of whole word complexity measures in studying the phonological acquisition is gaining importance in child language development research. The present study aims to explore phonological whole word complexity measures (PMLU, PWP & PWC) in sixty, 3 - 4 year old Tulu speaking children stratified into four age bands. The whole word complexity measures were estimated on picture naming task. A statistical significant increase in scores was noted amongst the four age groups for all the whole word complexity measures considered for the study. The comparison of scores in Tulu with earlier research in Kannada indicated a lower score, which was attributed to difference in the syllable structure, sample size and variation in the total number of segments attempted by the children. These measures have the potential to discover aspects of phonological acquisition that have been missed due to the focus on segments. Hence, normative data should be established specific to a language for different age groups using larger sample size.

Key Words: *Phonology, PMLU, PWP, PWC*

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Introduction

Phonology is the basic unit of speech. Hence, only phonemes were given emphasis in the phonological assessment. The traditional phonological assessment procedures included formal articulation tests, documentation of phonemic inventories and assessment of the phonological processes. Phonological assessment has involved both independent and relational analysis. However in clinical practice, a detailed phonological analysis is time consuming and tedious as they are focused mainly on segmental analysis. While the phonological acquisition has mostly focused on the segmental development, recently the attention has shifted to a broader view point through the analysis of syllables and whole word productions as words are being considered as the basic unit of analysis (Ingram & Ingram, 2001). This paper analyses such whole word complexity measures which are essential for the assessment of phonology at word level.

Credited with pioneering research in this area, Ingram and Ingram (2001) introduced a novel approach to measure the phonological acquisition in terms of whole word productions. Their purpose was to document changes in the phonological complexity of children's productions and intelligibility over time. In the current scenario, whole word complexity measures are gaining importance. Whole word complexity measures provide easier ways of phonological analysis compared to traditional approaches. Thus, it becomes essential to study them pertaining to every language to provide the normative data which in turn can be used in assessment.

The whole word complexity refers to the extent to which one word can be said to be more complex than another. A thorough measure of complexity will need to consider syllable and segmental complexity and some way to weigh the two. Phonological whole word complexity measures are ideally suited for estimating the phonological complexity of the words attempted and produced by the child as well as the rate at which a child approximates the target. Ingram and Ingram (2001) outlined four measures designed to assess children's abilities to produce whole words: Phonological Mean Length of Utterance (PMLU), Proportion of Whole word Proximity (PWP), Proportion of Whole word Correctness (PWC) and Proportion of Whole word Variability (PWV). Of particular interest in the present study are the PMLU, PWP and PWC measures. Ingram's PMLU is used to measure the complexity of child and adult targets and is a central component to each of the other measures.

Specifically, PMLU measures the length of a child's word (complexity) and the number of consonants produced correctly. PWP examines the relationship between the child's PMLU and the adult target PMLU, thereby providing evidence of how closely the child's production matches the target word. Ingram and Ingram (2001) suggested that PWP may also be used as an indirect measure of speech intelligibility given that it establishes a comparison between the child's word approximation and an expected target. The PWC is a simple measure that determines what proportions of the child's words are produced correctly out of the entire vocabulary.

These measures provide a straightforward means to assess the overall correctness of the child's productions with respect to the adult targets. Together, these measures cover correctness and complexity of whole-word productions. It has to be noted that phonological whole word measures are fairly broad and robust. Therefore, are neither designed as fine-

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grained phonological measures, nor should they be interpreted as such. Among the advantages are the relative ease with which the scores for the measures can be calculated and their potential applicability to a variety of settings. Hence, they can be modified as demanded by the particular linguistic environment, which is reflected by the diversity of environments these measures have been used.

PMLU quantifies development of phonology and focuses on the children's whole word productions instead of specific segments. Ingram (2002) demonstrates the value of the PMLU measure by applying it in a wide range of contexts. These include a comparison of monolingual children, a comparison across languages and the diagnosis of impairment or delay.

Phonological whole word measures have been applied to a variety of languages and children with typical and disordered languages. Studies are done using PMLU; however studies with PWP and PWC are very minimal. Ingram (2002) proposed preliminary PMLU stages, reflecting the possible level of development in English speaking children which are as follows Stage I with a range of 2.5-3.5 (midpoint – 3), Stage II with a range of 3.5-4.5 (midpoint – 4), Stage III with a range of 4.5-5.5 (midpoint – 5), Stage IV with a range of 5.5-6.5 (midpoint – 6) and Stage V with a range of 6.5-7.5 (midpoint – 7). Ingram (2002) reported the mean PWP value to be 0.64 and mean PWC value to be 0.12 in typically children between 11 months to 1 year 10 months.

Bedore (1999) noted that most Spanish phonemes are acquired by 4 years of age by most Spanish speaking children. This fact was highlighted by Loatman, Garland, Bunta, and Ingram (2003), noting that Spanish speaking 3 year olds have higher PMLU than their monolingual English counterparts at the same age. Phonological whole word measures were also used by Taelman, Durieux, and Gillis (2005) to investigate the phonology of Dutch children. The authors observed that the children's PMLU in their study became more varied as age increased, which is expected, because such variation is inherent in an expanding vocabulary as children add more complex words but keep producing the earlier acquired relatively simpler lexical items. Taelman et.al. (2005) noted a steady increase in PMLU at a rate of 0.18 a month for all but one of the children from 1.5–3 years of age. This rate of increase in the children's PMLU displayed a significant linear increase for eight of the nine children studied.

Helin, Makkonen, and Kunnari(2006) Studied 17 Finnish speaking 1-2 year old children and reported that PMLU scores were relatively higher and noted that they were more than 2.5 points higher than the English speaking children as reported by Ingram (2002). Also they found that PMLU and PWP scores for the Finnish children were closer to the scores from five children learning Spanish, which, they suggested, may be due to the fact that Spanish words tend to be longer than English words on average. Radhish and Jayashree (2009) reported an increase in the PMLU scores as age increased in Kannada speaking children between 3-7 years. Also found a rapid growth in the development in 3-4 years. While in the disordered population, studies have reported lower scores in the whole word complexity measures compared to the normal population. PMLU was studied in different disorders such as Down's syndrome (Archana, Sunila, Veena, Supriya, & Rajashekhar, 2011), Hearing impairment (Schauwers, Taelman, Gillis & Govier, 2005), Specific Language Impairment (Polite &

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Leonard, 2006), and phonological disorders (Radhish, Jayashree & Neitica, 2011) and the findings of these studies reveal that PMLU scores were lower for disordered population.

Need & Aim

Phonological development involves systematic expansion in segmental inventories, syllable structures and other aspects of the sound systems of their languages. The manner in which this systematic expansion occurs has several components, one of which appears to be the need to maintain a reliable level of approximation to the adult target form. Hence, whole word measures can shed light on how target approximations drive phonological acquisition. Whole word measures are simple and less time consuming. Hence, it is very easy to administer in the routine assessment if normative data is available. Thus, there is a strong need to study the phonological acquisition in terms of whole word measures.

Earlier studies have focused on the PMLU in English, Spanish and Finnish languages, but very few have considered the whole word measures like PWP and PWC (Ingram, 2002). Only recently, studies have focused on whole word measures such as PMLU in Indian languages like Kannada (Radhish & Jayashree, 2009). But there are limited researches done in the Tulu language. Tulu language is considered as one of the five major Dravidian languages. There is a greater cultural and linguistic variability between Tulu and other Dravidian languages. Hence, there is a need for studying the development of phonology using whole word complexity measures and providing a standardized data in Tulu due to its contrastive features with respect to other Dravidian languages; further, findings of this study are offered as a set of developmental data which can be used as a baseline for the assessment of phonology in Tulu speaking children.

The present study aims to explore phonological whole word complexity measures (PMLU, PWP and PWC) in 3-4 year old Tulu speaking children.

Method

A total of 60 normally developing children with Tulu (Common dialect) as their native language participated in the study. 15 children were selected in each group from 3 – 3.3, 3.4 – 3.6, 3.7 – 3.9 and 3.10 – 3.12 years. All children included in the study were from 23 Anganwadi centres in Udupi district. All the children were native Tulu speaking and had normal hearing, speech, language, social and cognitive development. Children with language age between 3 – 4 years of age as per Assessment of Language Development (Jayashree, Venkatesh & Lakkana, 2008) were only considered for the study.

Word list was developed to analyse the phonological processes in Tulu language and it was prepared as a part of Master's dissertation (Shruthi, 2010), considered in the present study. The word list consisted of 102 words out of which 25 words were randomly selected for the current study. Picture naming task was carried out. The recording duration for each child was around 10 minutes. Recording was done in a quiet room with a permissible noise limit and away from all modalities of distractions. No prompts were given; however, if the child did not give the correct response / no response, the child was acquainted with the correct response and the task was repeated with a time lag. Their responses were recorded using

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digital recorder (Sony digital voice editor 2.4, ICD – P series) placed 6 inches away from the child’s mouth.

Analysis

The speech sample of all the children were orthographically transcribed by the experimenter, using narrow transcription of the International Phonetic Alphabet (1996). After the transcription, PMLU, PWP and PWC were calculated. PMLU was calculated as per Ingram’s rules, 2001 (Appendix A). The PMLU for a speech sample was calculated by: assigning a point for each of the segments (consonants & vowels) in a word as produced by the child and an additional point for each of the consonants in that word that the child produced accurately; totalling these sums; and dividing this total by the total number of words in the sample. PWP relates the complexity of the child’s productions to that of the attempted adult targets. It is obtained by dividing the child’s PMLU score by the adult’s PMLU score. A further measure is the PWC, which is the ratio of correct attempts over the total number of productions. Child’s total number of correctly produced words was divided by total number of words to obtain PWC scores (Ingram, 2001)

Statistical Analysis

The data was further subjected to statistical analysis using SPSS 16.0 version. Mean and Standard Deviation (SD) for frequency of occurrence of PMLU, PWP and PWC values were calculated. ‘One way ANOVA’ was done to compare the mean score of each measure across the age groups with p value to be 0.05

Result

The objective was to study phonological development using whole word measures in children between 3 - 4 years of age. The whole word measures studied were PMLU, PWP and PWC. Children were categorized into 4 age groups, with 15 children in each age group.

Table 1: Mean & SD of PMLU, PWP and PWC scores across age groups

	PMLU		PWP		PWC	
	Mean	SD	Mean	SD	Mean	SD
3.1 – 3.3 years (Group 1)	6.734	0.103	0.892	0.013	0.554	0.029
3.4 – 3.6 years (Group 2)	6.944	0.101	0.920	0.013	0.646	0.036
3.7 – 3.9 years (Group 3)	7.200	0.134	0.954	0.017	0.716	0.063
3.10 – 3.12 years (Group 4)	7.397	0.047	0.980	0.006	0.834	0.055

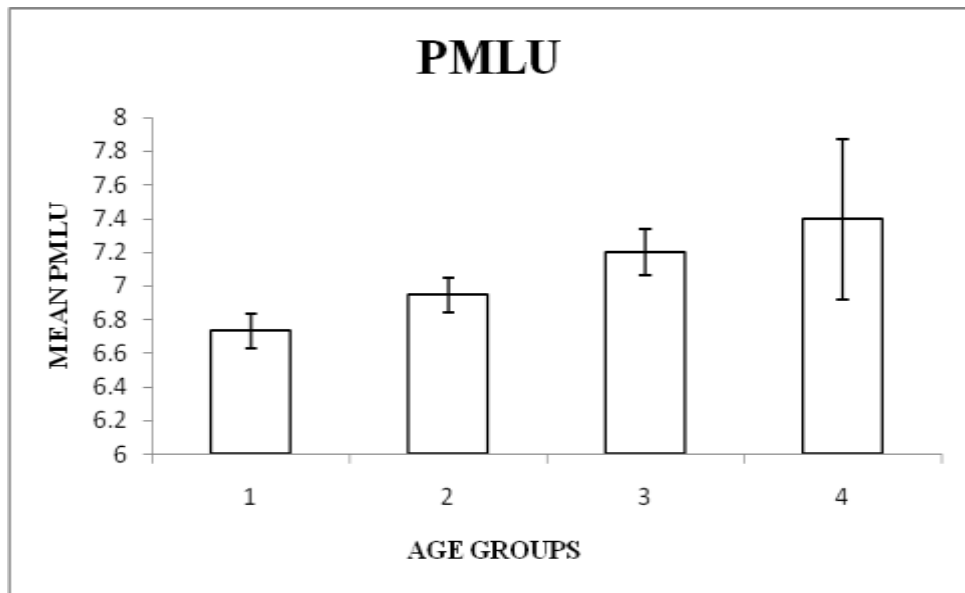
Graph 1: Showing mean and SD scores of PMLU across age groups

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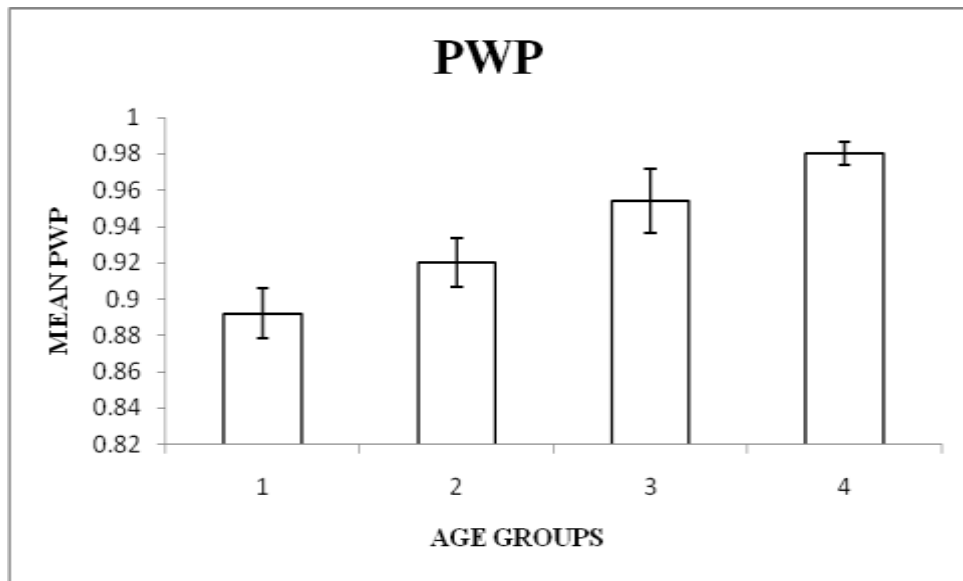
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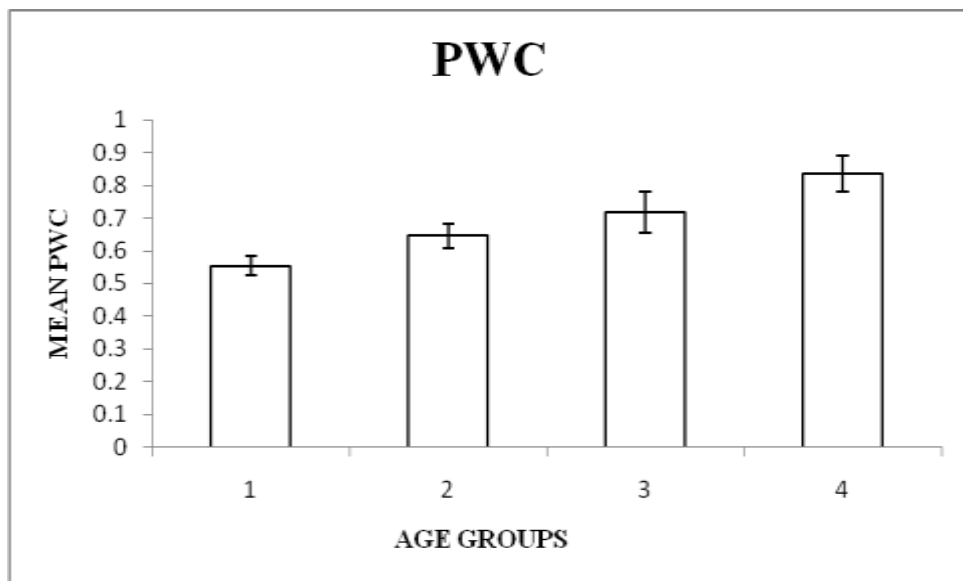
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Graph 2: Showing mean and SD scores of PWP across age groups



Graph 3: Showing mean and SD scores of PWC across age groups



As shown in table 1 and graph 1, the PMLU scores were 6.734, 6.944, 7.200 and 7.397 for age group 1, 2, 3 & 4 respectively. There is a clear developmental trend observed with respect to the mean PMLU values. The values increased with age and when subjected to statistical analysis there was statistically significant difference across all the age groups ($p < 0.05$).

As shown in table 1 and graph 2, the PWP scores were 0.892, 0.920, 0.954 and 0.980 for age groups 1, 2, 3, and 4 respectively. Similar to mean PMLU values, mean PWP values also

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increased with age and there was a statistically significant difference across age groups ($p < 0.05$).

As shown in table 1 and graph 3, the PWC scores were 0.554, 0.646, 0.716 and 0.834 for age groups 1, 2, 3, and 4 respectively. Mean PWC values also increased with age and the difference in the mean values were statistically significant across the age groups ($p < 0.05$).

Discussion

The findings suggest that for all the whole word measures, 3.1 – 3.3 years age group had significantly lower scores and 3.10 – 3.12 years age group had the highest score. A clear developmental style was observed across the age groups i.e. as the age increased there was an increase in scores, attributing to the child's overall articulatory proficiency and also, mastery of newer phoneme production.

In the current study, PMLU scores were 6.9 and 7.3 by 3.6 and 4 years of age respectively. In terms of PMLU findings the children between 3 – 3.6 years of age fell under the V stage and those between 3.7 to 4 years fell beyond the V stage as given by Ingram, 2002. However, these scores were significantly lower, when compared with Kannada (Radhish & Jayashree, 2009), in which the scores were above 7 by 3.6 years of age and above 8 by 4 years of age. The lower scores indicate the development is slower in Tulu compared to Kannada & English (Radhish & Jayashree, 2009; Ingram, 2001). This could also be attributed to difference in the syllable structure, sample size and variation in the total number of segments attempted by the children. The poor scores could also be due to the linguistic variability as analysis of specific languages indicated that the phonologies of some languages are acquired earlier than others (Bedore, 1999) and there is an evidence to suggest that PMLUs are longer in languages with longer words suggesting that children adjust their PMLUs according to the target language (Bunta, Fabiano-Smith, Goldstein, & Ingram, 2009).

In the current study, the PWP scores have shown significant increase with respect the age which clearly indicates that child's production approximates the adult form and that the child's productions become more intelligible as age advances.

PWC measures the overall correctness of the child's productions with respect to the adult targets. In the present study, the PWC scores also showed increase with age which could be attributed to increasing articulatory and cognitive control over speech production and hence, fewer errors. PMLU along with PWP and PWC gives a clearer image regarding the development of the phonology and whole word complexity.

Conclusion

Findings of the present study indicates that with increase in age children gain better articulatory proficiency, better approximation to the adult target words and thus, overall intelligibility. To conclude, Phonological whole word complexity measures gives us insight of the phonology in a broader view. It varies with the language structure, length and complexity of the utterance. Nevertheless, it is less tedious and time consuming when compared to the traditional assessment procedures. Thus, it can be used in clinical settings if standardized sample and age appropriate normative is used. However, this is a preliminary study. Hence, normative data should be established specific to a language for different age

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groups using larger sample size. This normative data may help us to measure word accuracy measures and thereby making our evaluations more easier and more accurate.

In the current study, single word elicitation task was carried out. The samples themselves may not have been representative of the phonological knowledge and abilities of all the participants, because the sample consisted of only 25 words. Also, the samples were not naturalistic as it was single word elicitation and not conversation. These measures are useful tools for studying child phonological acquisition, but other phonological analysis can provide a more in depth look at a given child's phonological system (such as phonemic inventories or phonological feature analyses). However, phonological whole word measures do provide valuable insights into phonological acquisition.

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Appendix A.

Rules for the calculation of Phonological mean length of utterance (PMLU):

Rules	Description
Sample size	Select at least 25 random words
Lexical class rule	Count words (e.g., common nouns, verbs, adjectives, prepositions and adverbs) that are used in normal conversation between adults. This excludes chills words (e.g., mommy, daddy, etc.)
Compound rule	Do not count compounds as a single word unless they are spelled as a single word (e.g., cowboy but not teddy bear; i.e., teddy bear would be excluded from the count)
Variability rule	Only count a single production for each word
Production rule	Count one point for each consonant and vowel that occurs in the child's production. Syllabic consonant receive one point (e.g., syllabic "l", "r" and "n")
Consonant correct rule	Assign one additional point for each correct consonant

Anuradha Shastry, BASLP (Corresponding Author)

Father Muller College of Speech and Hearing
A unit of Father Muller Charitable Institutions
Kankanady, Mangalore – 575002
shastryanuradha@gmail.com

Shruthi Nayak, MASLP

Department of ENT
M S Ramaiah Memorial Hospital
New B E L Road, M S Ramaiah Nagar, MSRIT Post,
Bangalore - 560 054
shruthinayakedu@gmail.com

Veena K. D., Ph.D.

Associate Professor, Department of Speech and Hearing
Manipal College of Allied Health Sciences, Manipal University
Manipal
Karnataka, India
r.veena@manipal.edu

Sunila John, MASLP

Assistant Professor, Department of Speech and Hearing
Manipal College of Allied Health Sciences, Manipal University
Manipal
Karnataka, India
sunila.john@manipal.edu

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MASLP

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