Original Research Article

PCC-R Measures for Pressure Consonants of Kannada Language: A Study on 3-4 Year Old Typically Developing Children and Children with Repaired Cleft Lip and Palate

Sahana Muralikrishna[1], Dr Pushpavathi M.[2]

[1]Assistant Professor, Samvaad Institute of Speech and Hearing, Hebbal, Bengaluru.
[2]Director, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006

Corresponding Author: Sahana Muralikrishna

ABSTRACT

The articulation and phonological skills play an important role in early linguistic development. The quantitative articulation analysis might provide ample evidence to predict a child's linguistic competence. The aim of the present study was to investigate the mean PCC-R (Percentage of consonants correct-Revised) scores of 3-4 year typically developing children and children with repaired cleft lip and palate (RCLP) using a developed word list of pressure consonants of Kannada language. The word list consisting of 14 pressure consonants (Stops: /p/, /b/, /t̪/, /d̪/, / t̪/, /d̪/, /k/, /g/; fricatives: /s/, /ʃ/, /h/, /v/ and affricates: /ʧ/, /ʤ/) of Kannada language in preceding and following contexts were used to investigate the PCC-R scores among typically developing children and children with RCLP. The mean PCC-R scores were also compared between the two groups. The responses elicited from the participants of the study were audio-recorded and the responses were transcribed using IPA transcription. The responses were tabulated using SPSS software (version 21) and the mean, standard deviation, median and quartile range were derived using descriptive statistics. The findings of the study revealed that most of the pressure consonants of Kannada language were acquired within the age of 3-4 years. The Mann Whitney U test revealed that there was a significant difference in PCC-R scores between typically developing children and children with RCLP ($p<0.01$). Children with RCLP had significantly poorer PCC-R scores. Affricate consonants were most affected followed by stops and fricatives.

Keywords: PCC-R scores, pressure consonant, Kannada, repaired cleft lip & palate.

INTRODUCTION

The articulation and phonological skills play an imperative role in early linguistic development. Articulation, phonology and linguistic development are interdependent. The articulation and phonological analysis might provide ample evidence to predict a child's linguistic competence. Therefore, it is important to have a detailed articulation and phonological analysis to facilitate early intervention. The phonological abilities and lexical development are the two distinguishing characteristics in identifying children as late talkers at an early age. Paul and Jennings (1992) reported that toddlers who were identified as late talkers had a smaller consonant repertoire and a lower percentage of consonant accuracy compared to their typically developing counterparts.

Based on the findings from their study, they endorsed that the total number of different consonants in a young child's inventory could be used as a sensitive indicator of development and delay. They also proliferated that syllable complexity serves as an effective means for monitoring phonological development.

Williams and Elbert (2003) carried out a longitudinal study on five late talkers to examine the course of phonological development which could in turn serve as possible predictors of delayed versus deviant development. They examined both qualitative and quantitative aspects of phonological and linguistic development. The phonetic and phonological measures that were considered for their study were phonetic inventory, syllable structure, syllable diversity, sound variability, the percentage of consonants correct, and error patterns. They reported that both quantitative and qualitative phonetic and phonological measures were important in determining recovery from late talking or persistence of a phonological delay.

The relevance of early phonological assessment is of paramount importance in identifying children who are at risk for delayed or deviant speech and language development. It is also very vital for children with cleft lip and or palate (CLP) who are at risk for early speech and language delays due to the presence of the cleft during the first year of life (Scherer, N.J., D'Antonio & McGahey 2008). The language delay that persists through the preschool period, may impact early literacy skills (Chapman, 2011). The congenital structural deficits such as cleft lip and palate, hampers the inventories of speech sounds of young children with CLP, which in turn confines vocabulary growth. Based on findings of research studies, it is quite markedly noted that young children with CLP produce more words beginning with nasals, vowels, glides, and fewer words beginning with oral stop consonants than compared to typically developing children. The children with CLP show an early preference for sounds made at the labial, velar, and glottal place of articulation. (Estrem and Broen, 1989).

The research in normal and disordered phonology entails measures of speech production that are linguistically and metrically robust. The detailed quantitative measures focus on investigating the phonological skills in typically developing children and children with repaired CLP. The quantitative measures such as Percentage of Consonants Correct (PCC) and its other extensions such as PCP (Percentage of consonants correct with respect to place of articulation), PCM (Percentage of consonants correct with respect to manner of articulation), PVC (Percentage of vowels correct), PCV ((Percentage of consonants correct with respect to voicing) provide a rationale to assess articulation competence (Shriberg & Kwiatkowski, 1982). This measure is computed from a 5 to 10 minute conversational speech sample.

The Percentage of Consonants Correct (PCC) measures accounts for the percentage of intended consonant sounds in a conversational sample that was articulated correctly. Since its conception and updated development (Shriberg et al., 1986), variants of this approach have been used by investigators tracking varied questions in child phonology. However, sometimes there seem to be a different procedures employed when deriving the PCC measures. For example, PCC's have sometimes been used to represent the percentage of correct consonants on a diagnostic articulation test or some other non-conversational speech tasks. Nevertheless, the integrity of such procedures remains intact in deriving the PCC measures.

The early intervention for children with CLP might enable the change in the trajectory of early speech and language development. This can only be achieved when a detailed speech assessment can be carried out that can address the communication problems faced by children with CLP. Nonetheless, limitations in

speech assessment materials for children with CLP might restrict the ease and accuracy of speech sound assessment. A single-word measure of speech production would be advantageous in identifying children who would benefit from early intervention as they provide information about phonological development.

The articulation and phonological skills can be assessed by using various tests such as screening, diagnostic and deep test of articulation. The deep test of articulation is one of the diagnostic tests in which each sound is tested in all possible vowel and consonant phonetic contexts. This might rather serve as a detailed speech assessment material when deriving the quantitative measures such as PCC. It provides detailed information about phoneme tested. The diagnostic test of articulation in Kannada was developed by Babu, Rathna and Bettagiri (1972). The KAT consisted of 52 words in initial and medial positions, 10 clusters and passage reading subtest for those who could read. The restandardization of the diagnostic test was done by Deepa and Savithri (2010). The restandardized test developed comprised of two parts. The part I of the test consisted of 52 words, ten vowels, two diphthongs, 19 consonants in each initial and medial word position. The second part of the test contained 62 words with ten vowels, one diphthong, 19 consonants in initial and medial word position and 11 clusters in naturally occurring positions.

The diagnostic articulation gives information about the ability of the child to produce a wide range of speech sounds in various positions and phonetic contexts. On the other hand, the deep test of articulation assesses a single target phoneme in various possible contexts and positions to analyze the precision or imprecision of the phoneme production. Rohini (1989) developed a deep test of articulation in Kannada (sentence form). The test was developed for only 13 consonants (/ḍ/, /ḏ/, /g/, /h/, /v/, /ṇ/, /s/, /ʃ/, /j/, /r/, /l̥/, /ʧ/, /ʤ/) The target consonants selected for their study were the most frequently misarticulated consonants. The consonants were developed in different vowel-consonant and consonant cluster contexts. The test comprised of 3 to 4 word long meaningful sentences. There were a total of 305 sentences which were developed including 108 sentences in consonant clusters. The results from the study revealed that articulation proficiency improved with age.

The articulation and phonological skills are the most common type of communication problems faced by children with CLP. Therefore, the need for a more appropriate articulation test that can be used among CLP population is of paramount significance. The pressure consonants that are mostly affected in children with CLP should be given more importance while developing an articulation test. Currently, none of the diagnostic articulation tests in the Kannada language accounts for deep testing the pressure consonants at the word level. The deep test of articulation in the sentence form developed by Rohini (1989) accounted for only nine pressure consonants at sentence level. Therefore, this is a preliminary effort to develop a word list using pressure consonants of Kannada language and also to develop mean PCC-R scores for these developed word list using quantitative measures. The mean PCC-R scores would be helpful in establishing a baseline when the phonological skills need to be compared with the disordered population like cleft lip and palate. In order to achieve unimpeachable information about articulatory proficiency, there is a need to use a deep test of articulation which can provide detailed information about phonemes because it would be tested across various possible vowel and consonant contexts.

Aim of the Study

- The aim of the present study is to investigate PCC-R measures of 3-4 year typically developing children and children with repaired CLP using a developed word list of pressure consonants

Objectives of the Study

- To investigate PCC-R scores for target stop consonants in the preceding and the following context among 3-4 year old typically developing children and PCC-R scores of children with repaired CLP
- To investigate PCC-R scores for target fricative consonants in preceding and following context among 3-4 year old typically developing children and PCC-R scores of children with repaired CLP
- To investigate PCC-R scores for target affricate consonants in preceding and following context among 3-4 year old typically developing children and PCC-R scores of children with repaired CLP
- To compare the PCC-R scores of pressure consonants in preceding and following context among 3-4 year old typically developing children and children with repaired CLP

METHOD

The present study intended to assess phonetic skills among 3-4 year Kannada speaking children using a developed word list which only consists of pressure consonants. The phonemes in the Kannada language are represented in Table 1. The pressure consonants in Kannada were identified by reviewing the Kannada phonetic reader (Upadhyaya, 2000). There are a total of 14 pressure consonants (without aspirated consonants) in the Kannada language. The aspirated pressure consonants were not considered as target phonemes in the present study as they are not much used in general colloquial conversations.

Table 1

Vowels/ Consonants	Total number
Vowels	Short vowels -5,Long vowels- 5
Diphthongs	2
Stop consonants (aspirated and unaspirated)	16
Nasal consonants	4
Fricatives	5
Affricates (aspirated and unaspirated)	4
Laterals	2
Trills	1
Semivowels	2

Table1: Phonemes in Kannada language (Upadhyaya, 2000)

The pressure consonants of Kannada language are as follows: Stops: / p/, /b/, /t̪/, /d̪/, / ʈ/, / ɖ/, /k/, /g/; fricatives: /s/, /ʃ/, /h/, /v/ and affricates: /ʧ/, /ʤ/

DEVELOPMENT OF THE WORD LIST

The word list which was developed had 14 pressure consonants as target consonants. The words were developed for each target pressure consonant in preceding and following contexts of various vowels and consonants. The word list prepared consisted of a minimum of 1 word and a maximum of 3 words in each context in preceding and following milieu. The word list consisted of 578 words in preceding and 402 words in the following context. The word list was given to three SLP's and two preschool teachers for a familiarity testing. The words were rated as very familiar, familiar and unfamiliar.

The judges rated 321 words as very familiar, 165 words as familiar and 92 words as unfamiliar in preceding context. In the following context, 227 words were rated as very familiar, 121 words as familiar, and 54 as unfamiliar. If there were more than one word which was rated as very familiar in any context, the word which was rated as very familiar by the most number of judges was selected. The final list compromised of 519 words (277 words in preceding context & 242 words in the following context) of 14 different pressure consonants in the different vowel and consonant contexts. The distribution of the words based on a familiarity rating scale has been depicted in table 2. The final word list was then made into picture form. The simple line drawings depicting the words selected were drawn by a professional artist. The pictures were carefully selected after considering the clarity and non-ambiguity in representing the words. This developed word list was used to assess phonetic skills among typically developing children and children with CLP.

Participant selection criteria for typically developing children

The subjects selected for the current study were 30 typically developing children in the age range of 3-4 years. The native speakers of Kannada language belonging to middle socio-economic status were selected for the study. The socio economic status information was obtained by administering the Socio Economic Status Scale developed by Venkatesan (2011). The subjects were free from any speech, language, hearing or any other motor difficulties. This information was obtained by teachers/ parents and also by administering WHO Ten Questions Screen (TQS) developed by Durkin et al. (1995). The language test (Extended REELS are given by Bzoch and League, 1979) was administered to find out any delay or deviancy in language development.

Table 2: *Distribution of words across different pressure consonants*

Target sound	Context	Total words constructed	Very familiar	Familiar	Unfamiliar	Total words selected
/k/	P	56	35	13	8	29
	F	36	18	11	7	22
/g/	P	49	31	11	7	22
	F	38	18	15	5	24
/ʈ/	P	24	13	8	3	13
	F	39	23	13	3	20
/ɖ/	P	13	4	3	6	7
	F	21	15	6	0	16
/t̪/	P	47	20	15	12	21
	F	37	20	10	7	19
/d̪/	P	44	25	12	7	19
	F	34	20	8	6	19
/p/	P	47	25	11	11	25
	F	35	25	8	2	20
/b/	P	61	37	14	10	28
	F	35	22	9	4	20
/ʧ/	P	36	18	10	8	16
	F	21	10	6	5	11
/dʒ/	P	41	26	10	5	19
	F	23	15	4	4	15
/s/	P	52	24	20	8	26
	F	39	23	11	5	20
/ʃ/	P	24	10	11	3	11
	F	11	4	5	2	9
/v/	P	24	11	11	2	15
	F	26	12	12	2	17
/h/	P	59	42	15	2	26
	F	12	5	5	2	10

Inclusion criteria for children with repaired cleft lip and palate

Five children with repaired cleft lip and palate (operated before 2yrs of age) in the age range of 3-4 (average age of 3.6 yrs) years were considered for the study (2 male children with a provisional diagnosis of misarticulation with RCLP, 1 female child with expressive language delay with RCLP and 2 female children with a provisional diagnosis of misarticulation with RCLP). Children with only non syndromic cleft were selected for the study. Children with the presence of any fistulae in the palate were not included. All the subjects selected had normal hearing sensitivity. The subjects selected for the study underwent hearing screening. The presence of any cognitive, vision and hearing impairments were ruled out by administering the WHO Ten Questions Screen (TQS) developed by Durkin et al. (1995). Subjects selected for the study had Kannada as their native language and belonged to middle socio economic status. The socio economic status information was obtained by administering the Socio Economic Status Scale developed by Venkatesan (2011). The language skills were assessed by administering the language test (Extended REELS given by Bzoch and League, 1979). Children who had receptive language delay were not included in the study.

ADMINISTERING THE TEST

The word list developed to assess 14 pressure consonants across different contexts consisted of 519 words. Each child was examined individually in a noise free environment, comfortably seated, next to the examiner. The instructions given to the subjects before administering the test were as follows: "I will show you some pictures, you will have to name the pictures one after the other. If you are not able to name the pictures, I will help you name the pictures". In order to help children name the pictures, additional cues were given. If the child failed to name the picture despite of giving additional cues (like semantic cues or the initial letter of the picture) the child was asked to repeat the words after the examiner. The children were instructed to say the words (containing the target sound in preceding or following context) in the picture form test.

The responses were audio recorded using a DELL laptop. The recorded responses were transcribed using IPA (International Phonetic Alphabet). The transcribed data was used further to determine the accuracy of each production. The PCC-R measures (given by Shriberg, Austin, Lewis, McSweeney, & Wilson, 1997) were derived based on the responses obtained after administering the word list developed for the deep test of articulation using pressure consonants in Kannada. The PCC-R was calculated using the following formula:

$$\frac{No.of\ consonants\ correctly\ produced}{No.of\ correct\ and\ incorrect\ consonant\ productions} X\ 100$$

The statistical analysis was carried out using SPSS software (Version 21). Descriptive statistical analysis and non-parametric test such as Mann Whitney U test were used for the present study.

RESULTS AND DISCUSSION

The word list developed that was administered in the current study is a list developed by using pressure consonants of Kannada language. This test material was developed to determine the production of speech sounds, specifically pressure consonants in the different vowel and consonant context while it occurs in preceding and following positions. The responses were audio recorded. The audio samples were then transcribed using IPA. The responses were calculated in terms of PCC-R scores. The PCC-R scores were calculated separately for each pressure consonants. The PCC-R scores were calculated for preceding context, following context and an average PCC-R scores were also calculated. The statistical analysis was carried out using SPSS software (Version 21). The mean, standard deviation, median and quartile range were derived using descriptive statistics.

The first objective of the study was to investigate the PCC-R scores for stop consonants in preceding and following context among 3-4 year old typically developing children and PCC-R scores of children with CLP.

The Table 3 represents the mean, standard deviation, median scores and quartile range for all the stop consonants in preceding, following contexts and total PCC-R scores. There are 8 stop consonants (/p/, /b/, /k/, /g/, /t̪/, /d̪/, /ʈ/ and /ɖ/) in Kannada language. The mean scores and standard deviation of /p/ in preceding context was 99.24 % and 1.72 respectively, 99.62 % and 1.41 in following context, /b/ in preceding context was 98.00 % and 3.23 respectively, 99.06 % and 2.13 in following context, /k/ in preceding context was 98.68 % and 4.73 respectively, 98.70 % and 3.48 in following context , /g/ in preceding context was 98.02 % and 3.52 respectively, 98.09 % and 4.07 in following context , /t̪/ in preceding context was 98.33 % and 4.65 respectively, 98.81 % and 2.28 in following context, /d̪/ in preceding context was 98.23 % and 5.38 respectively, 98.24 % and 3.74 in following context , /ʈ/ in preceding context was 98.33 % and 4.03 respectively, 99.47 % and 2.11 in following context , /ɖ/ in preceding context was 96.00 % and 9.68 respectively, 90.62 % and 17.35 in following context. This implies that the

children who participated in the study (age range of 3 to 4 years) had almost acquired all the stop consonants (Criterion of 90% and above).

In the children with RCLP group, the mean scores and standard deviation of /p/ in preceding context was 16.36 % and 11.40 respectively, in following context the mean scores and SD were 34.44% and 23.03 respectively; /b/ in preceding context was 29.62 % and 29.16 respectively, in following context the mean scores and SD were 32.21% and 29.23; /k/ in preceding context was 36.42 % and 36.71 respectively, in following context the mean scores and SD were 38.88 % and 31.42 ; /g/ in

preceding context was 30.47 % and 36.51 respectively, in following context the mean scores and SD were 38.09 % and 35.79; /ṭ/ in preceding context was 11.10 % and 6.80 respectively, in following context the mean scores and SD were 28.16 % and 17.56 ; /ḍ/ in preceding context was 29.40 % and 18.13 respectively, in following context the mean scores and SD were 27.59 % and 17.11; /t̪/ in preceding context was 4.99 % and 7.45 respectively, in following context the mean scores and SD were 17.89 % and 24.85; /d̪/ in preceding context was 12.00 % and 10.95 respectively, in the following context the mean scores and SD were 23.75% and 26.66.

TABLE 3: Mean PCC-R scores for Stop consonants in preceding and following contexts for typically developing children and PCC-R scores of children with repaired CLP

STOPS	Typically developing children				Children with cleft lip and palate			
	Mean	SD	Median	Quartile Range	Mean	SD	Median	Quartile range
/p/_pre_PCC	99.24	1.72	100.00	.00	16.36	11.40	18.18	9.09
/p/_Foll_PCC	99.62	1.41	100.00	.00	34.44	23.03	44.44	20.83
/p/_total_PCC	99.43	1.04	100.00	.28	25.40	15.76	34.09	13.13
/b/_pre_PCC	98.00	3.23	100.00	1.85	29.62	29.16	29.62	25.92
/b/_foll_PCC	99.06	2.13	100.00	.00	32.21	29.23	27.77	25.00
/b/_total_PCC	98.47	1.85	100.00	1.57	30.92	28.94	32.40	24.53
/k/_pre_PCC	98.68	4.73	100.00	.00	36.42	36.71	14.28	33.03
/k/_foll_PCC	98.70	3.48	100.00	.00	38.88	31.42	55.55	29.16
/k/_total_PCC	98.69	3.29	100.00	.00	37.65	32.17	34.91	31.10
/g/_pre_PCC	98.02	3.52	100.00	2.3	30.47	36.51	19.04	33.33
/g/_foll_PCC	98.09	4.07	100.00	0.59	38.09	35.79	33.33	34.52
/g/_total_PCC	98.05	3.36	100.00	1.19	34.28	32.41	28.56	27.38
/ṭ/_pre_PCC	98.33	4.65	100.00	.00	11.10	6.80	11.11	5.55
/ṭ/_foll_PCC	99.29	2.28	100.00	.00	28.16	17.56	21.05	14.16
/ṭ/_total_PCC	98.81	3.02	100.00	.00	19.23	8.24	18.85	7.27
/ḍ/_pre_PCC	98.23	5.38	100.00	.00	29.40	18.13	23.52	16.18
/ḍ/_foll_PCC	98.24	3.74	100.00	0.66	27.59	17.11	26.31	14.18
/ḍ/_total_PCC	98.23	3.94	100.00	1.33	28.50	15.35	22.87	13.35
/t̪/_pre_PCC	98.33	4.03	100.00	.00	4.99	7.45	.00	6.25
/t̪/_foll_PCC	99.47	2.11	100.00	.00	17.89	24.85	5.26	21.05
/t̪/_total_PCC	98.90	2.17	100.00	.33	11.44	12.92	4.16	11.95
/d̪/_pre_PCC	96.00	9.68	100.00	.00	12.00	10.95	20.00	10.00
/d̪/_foll_PCC	90.62	17.35	100.00	3.13	23.75	26.66	18.75	25.00
/d̪/_total_PCC	93.31	12.78	98.43	2.35	17.67	14.87	18.75	12.40

Note pre- Preceding, foll- Following*

The retroflex stop consonants /ṭ/ and /ḍ/ were more affected compared to alveolar stop consonants /t̪/ & /d̪/, bilabial stop consonants /p/ and /b/ and velar stop consonants /k/ & /g/. It can be noted that the stop consonants were slightly better produced in the following contexts compared to the preceding context. Unlike typically developing children, the children with repaired CLP had high standard deviation and varying median scores.

The findings of this study are in accordance with findings of other studies done on speech sound acquisition (Deepa and Savithri, 2010; Pratima, 2009; Arun Banik, 1988). The findings of western studies also support the findings of the present studies. Most of the studies have reported that stop consonant acquisition is usually achieved by 3 to 4 years (Sanders, 1972; Smith et al., 1990; McIntosh & Dodd, 2008).

The review of the literature has highlighted that children with cleft lip and palate have difficulty in producing pressure consonants. According to the findings of McWilliams (1990), children with cleft lip and palate have reduced intraoral breath pressure. The presence of cleft might impair the intra oral breath pressure which can impact the production of stop consonants. It is clear from the table that the stop consonants were better produced in the following context when compared to preceding contexts . The order of difficulty in producing stop consonants showed that /t̥/ was produced with greater difficulty , followed by /d̥/, /t̪/, /d̪/, /g/, /b/, /p/ and /k/. The median scores of /k/ were relatively better compared to other stop consonants.

The second objective of the study is to investigate the PCC-R scores for fricative consonants in preceding and following context among 3-4 year old typically developing children and PCC-R scores of children with repaired CLP.

TABLE 4: Mean PCC-R scores for Fricative consonants in preceding and following contexts for typically developing children and PCC-R scores of children with repaired CLP

FRICATIVES	Typically developing children				Children with cleft lip and palate			
	Mean	SD	Median	Quartile Range	Mean	SD	Median	Quartile Range
/s/_pre_PCC	96.34	13.90	100.00	0.59	6.66	4.25	4.76	2.38
/s/_foll_PCC	89.47	26.73	100.00	2.63	16.83	10.78	21.05	10.52
/s/_total_PCC	92.90	18.50	100.00	2.41	11.74	6.69	12.90	6,45
/ʃ/_pre_PCC	89.62	28.43	100.00	.00	20.00	44.72	.00	25.00
/ʃ/_foll_PCC	90.55	23.44	100.00	.00	20.00	44.72	.00	25.00
/ʃ/_total_PCC	90.09	24.33	100.00	1.04	20.00	44.72	.00	25.00
/v/_pre_PCC	96.10	6.82	100.00	4.17	61.66	18.25	66.66	14.58
/v/_foll_PCC	98.57	6.60	100.00	.00	69.99	23.36	71.42	19.64
/v/_total_PCC	97.33	5.74	100.00	2.08	65.82	15.65	64.87	12.50
/h/_pre_PCC	96.00	7.71	100.00	2.00	52.80	34.68	68.00	31.00
/h/_foll_PCC	93.33	10.75	100.00	6.25	42.50	25.92	37.50	18.75
/h/_total_PCC	94.66	8.50	98.00	3.12	47.65	26.87	52.75	24.87

Note* pre- Preceding, foll- Following

The Table 4 represents the mean PCC-R scores for fricative consonants in preceding, following contexts, and total PCC-R scores. There are 4 fricative consonants (/s/, /ʃ/, /v/, /h/) in Kannada language. The mean scores and standard deviation of /s/ in preceding context was 96.34 % and 13.90 respectively, 89.47 % and 26.73 in following context, /ʃ/ in preceding context was 89.62 % and 28.43 respectively, 90.55 % and 23.44 in following context, /v/ in preceding context was 96.10 % and 6.82 respectively, 98.57 % and 6.60 in following context, /h/ in preceding context was 96.00 % and 7.71 respectively, 93.33 % and 10.75 in following context. The standard deviations for PCC-R scores for fricatives were slightly higher compared to stop consonants. Nevertheless, the median for all the fricative consonants was at 100 except for /h/ which was at 98.00.

From Table 4, it can be noted that, for children with RCLP the mean and SD for the pressure consonant /s/ in preceding.

context was 6.66 % and 4.25 respectively, in the following context the mean scores and SD were 16.83% and 10.78; /ʃ/ in preceding context was 20 % and 44.72 respectively, in following context the mean scores and SD were 20 % and 44.72; /v/ in preceding context was 61.66 % and 18.25 respectively, in following context the mean scores and SD were 69.99% and 23.36; /h/ in preceding context was 52.80 % and 34.68 respectively, in the following context the mean scores and SD were 42.50% and 25.92. The poorer score was noted for alveolar fricative /s/ and post alveolar fricative /ʃ/ while the maximum PCC-R score was obtained for labiodental fricative /v/. The decreasing order of difficulty of fricative production was /s/, /ʃ/, /h/ and /v/. When compared to typically developing children, the SD and median scores were highly variable.

More recent studies (Grunwell, 1981; Smit, Hand, Frelinger, Bernthal, & Bird, 1990; Goldman & Fristoe, 2000) reported that fricatives were generally acquired in the age range of 3-5 years. In the

Indian context, the study done by Prathima (2009) and Deepa & Savithri (2010) estimated the age of acquisition to be around 3 to 4 years. The findings of the present study are in agreement with the recent findings of Deepa & Savithri (2010).

It is evident from the Table 4 that only /s/ sound was better produced in following context when compared to preceding context. The other fricative consonants such as /ʃ/ and /v/ had no difference in median scores for preceding and the following context. The median scores for /h/ were relatively better in the preceding than the following context. The order of difficulty in producing fricative consonants showed that /ʃ/ was produced with greater difficulty, followed by /s/, /h/ and /v/. The median scores of /v/ were comparatively better compared to other fricative consonants.

Fricative consonants are high pressure consonants. Children with RCLP might have difficulty in generating audible friction due to their structural restrictions and poor intraoral breath pressure control. This might be the plausible cause of poorer mean PCC-R scores among children with RCLP.

The third objective of the study was to investigate mean PCC-R scores for affricate consonants in preceding and following context among 3-4 year old typically developing children and PCC-R scores of children with repaired CLP.

TABLE 5: Mean PCC-R scores for Affricate consonants in preceding and following contexts for typically developing children and PCC-R scores of children with repaired CLP

AFFRICATES	Typically developing children				Children with cleft lip and palate			
	Mean	SD	Median	Quartile Range	Mean	SD	Median	Quartile Range
/ʧ/_pre_PCC	95.99	13.74	100.00	.00	22.66	33.86	6.66	26.66
/ʧ/_foll_PCC	92.91	25.36	100.00	.00	17.50	24.36	.00	21.87
/ʧ/_total_PCC	94.45	18.51	100.00	.00	20.08	28.49	3.33	24.27
/ʤ/_pre_PCC	98.23	5.81	100.00	.00	15.29	28.08	.00	19.11
/ʤ/_foll_PCC	94.74	14.64	100.00	0.89	14.28	31.93	.00	17.85
/ʤ/_total_PCC	96.48	9.67	100.00	1.55	14.78	29.88	.00	18.48

Note* pre- Preceding, foll- Following

The table 5 represents the normative PCC-R scores for affricate consonants in the preceding, following contexts, and total PCC-R scores. There are two affricate consonants (/ʧ/ and /ʤ/) in the Kannada language. The mean scores and standard deviation of /ʧ/ in the preceding context was 95.99 % and 13.74 respectively, 92.91 % and 25.36 in the following context, /ʤ/ in preceding context was 98.23 % and 5.81 respectively, 94.74 % and 14.64 in following context. The SD values were comparatively higher than stop consonants. The median for all the affricate consonants was at 100.

The research on speech sound acquisition across various Indian languages has approximated the age of acquisition of affricates to be around 3 to 4 years (Arun Banik, 1988; Usha, 1986; Padmaja, 1988).

The present study is concurrent with the study done by Prathima (2009) and Deepa and Savithri (2010) in the Kannada language, who estimated the age of acquisition of affricates to be around 3 to 3.6 years.

The children with RCLP had poor PCC-R scores for alveolar affricates /ʧ/ and /ʤ/. The affricate /ʧ/ in the preceding context had a mean PCC-R score and SD of 22.66 % and 33.86 respectively, in the following context the mean scores and SD were 17.50% and 24.36; affricate /ʤ/ in the preceding context had a mean PCC-R score and SD of 15.29 % and 28.08 respectively, in the following context the mean scores and SD were 14.28% and 31.93. They also exhibited high SD and varying median scores. There was no significant difference between the preceding and following contexts. The poor PCC-R scores in children with RCLP might be attributed due to the factor that affricate production begins as a stop (sound with complete obstruction of the breath stream) and concludes with a fricative (sound with incomplete closure and

a sound of friction). This requires far more intrinsic actions of the articulators when compared to other stop or fricative consonant production.

The graph 1 represents the mean PCC-R scores for all the pressure consonants (stops, fricatives and affricates) in preceding and following contexts. The median for all the pressure consonants were ranging from 99 to 100. The Mean PCC-R scores revealed that stop consonants were slightly better produced by typically developing children compared to affricates and fricatives. The children with RCLP had comparatively better scores for fricative consonants followed by stop and affricate consonants.
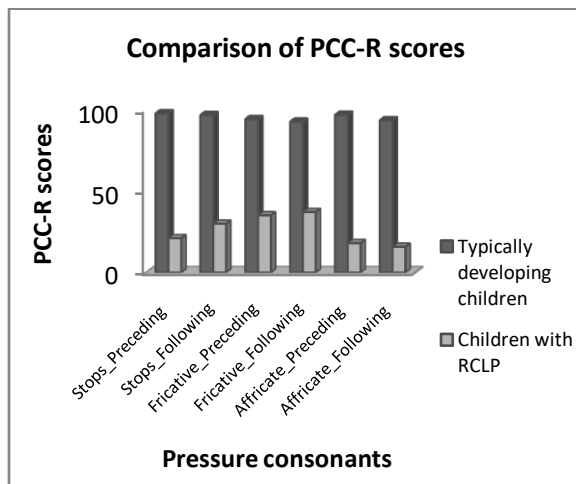
It can be observed from Graph 1, that children with RCLP had poorer scores across all pressure consonants. Comparatively, the mean PCC-R scores revealed that fricatives and stops were better produced than affricate consonants. There was no difference in PCC-R scores of children with RCLP and typically developing children in both preceding and following contexts.

Another objective of the present study is to compare the phonetic skills of typically developing children and children with RCLP. Considering the sample size, non-normality and high standard deviation, non-parametric tests were carried out to find the difference between typically developing children and children with repaired cleft lip and palate. The non-parametric Mann-Whitney U test was performed to compare the mean PCC-R scores between typically developing children and children with repaired CLP. The pressure consonants were tested across preceding and following contexts and the PCC-R values were compared between the two groups.

Comparison of PCC-R scores

Graph 1

TABLE 6: Comparison of mean PCC-R scores of pressure consonants among typically developing children and children with repaired cleft lip and palate considering p value <0.01

MANN WHITNEY U TEST				
	Pressure consonant	Preceding context	Following context	Average PCC-R
		|z|	|z|	|z|
	Stop Consonants			
1	/p/	4.444	5.061	4.185
2	/b/	3.930	4.439	3.723
3	/k/	4.541	4.604	4.295
4	/g/	4.000	4.127	3.807
5	/ʈ/	4.437	4.807	4.296
6	/ɖ/	4.603	4.185	4.078
7	/t̪/	4.441	5.061	4.181
8	/d̪/	4.441	3.543	3.707
	Fricative consonants			
9	/s/	4.189	3.495	3.817
10	/ʃ/	3.296	3.259	3.127
11	/v/	3.870	4.056	3.841
12	/h/	3.633	3.542	3.516
	Affricate consonants			
13	/ʧ/	4.348	4.369	4.123
14	/ʤ/	4.604	4.071	4.025

Note* pre- Preceding, foll- Following

The Table 6 represents the Z values for stop, fricative and affricate (collectively called as pressure consonants) consonants. The findings reveal that that P value was found to be less than 0.01, which indicate that there is a very significant difference found in PCC-R scores among typically developing children and children with repaired cleft lip and palate. The findings also concur that the pressure consonants were greatly affected among children with cleft lip and palate. The affricate consonants were greatly affected when compared to fricatives and stop consonants. This might be due to the factor that production of affricates might require greater intra oral air pressure control which might be impaired among children with RCLP (Chapman, K.L., 1993; Harding & Grunwell, 1996; Hardin-Jones, Chapman, & Scherer, 2006).

The plosives /p/, /b/, /t/, /d/, /k/, /g/, fricatives /f/, /v/, /s/, /ʃ/, /z/ and affricates /ʧ/, /dʒ/ have been found to be more affected than the other phonetic classes such as nasals /m/, /n/, /ŋ/ and glides /j/ and /w/ (Chapman, 1993; Harding & Grunwell, 1996; Hardin-Jones, Chapman, & Scherer, 2006). The findings of Morris and Ozanne (2003) also reported that three year old children with cleft lip and palate have disordered phonological skills rather than delayed skills. They also noted that children with CLP have lower PCC scores compared to their peer groups. The recent study was done by Deepthi & Pushpavathi (2017) also reported that stops, affricates, fricatives, trill, lateral approximant and approximants were generally affected among Kannada speaking preschool children with RCLP. The findings of the present study are in lieu with other research studies (Deepthi & Pushpavthi, 2017; Hardin-Jones, Chapman, & Scherer, 2006) which have emphasized that children with cleft lip and palate have greater difficulty in producing pressure consonants.

The mean PCC-R scores established for typically developing children reveal that most of the pressure consonants are acquired within 3 – 4 years of age. The age of acquisition of different speech sounds has been debatable when reviewing the research studies. The study done around 1970s and 1980s had reported different age of acquisition for various pressure consonants. The recent study was done by Prathima (2009) and Deepa & Savithri (2010) has highlighted that most of the pressure consonants are acquired within 3 to 4 years. When comparing the speech sound acquisition studies of western context and Indian context, it can be noted that different speech sounds in Indian languages are relatively faster compared to western studies. It can be presumed that present day children are much ahead in their articulatory acquisition compared to their earlier counterparts due to increased exposure, stimulation and enormous resources to expedite the learning process.

CONCLUSION

The present study aimed to investigate mean PCC-R scores for 3 to 4 year old typically developing children and children with RCLP using a word list developed only using pressure consonants. The study also aimed to compare the PCC-R parameter between typically developing children and children with RCLP. The findings of the study revealed that 90% of the pressure consonants were already acquired by the age of 3 to 4 years

(Criterion level between 90% - 100%). There seems to be significant difference between the two groups with respect to PCC-R scores. Children with RCLP had significantly lower PCC-R scores when compared to typically developing children. The study infers that pressure consonants are greatly affected (affricates being most affected followed by fricatives and stop consonants) in children with repaired cleft lip and palate. The deep test of articulation word list used in the present study will provide reliable PCC-R scores as the target pressure consonants will be tested across various vowel and consonant

contexts. However, the research study should be conducted on a larger clinical population, across different age groups to strengthen the findings of the current study.

REFERENCES

- Banik, A. (1988). Articulation test in Bengali. *Students research at AIISH*, 2. University of Mysore, Mysore.
- Babu, R.M., Rathna, N., & Bettagiri, R. (1972). Test of articulation in Kannada. *Journal of AIISH*, 3, 64-79.
- Bzoch, K.R. (1979). *Communicative Disorders Related to Cleft Lip and Palate*, 2nd edn. Boston, MA: Little Brown.
- Chapman, K.L. (1993). Phonologic process in children with cleft palate. *Cleft Palate Craniofacial Journal*, 30(1), 64-72.
- Chapman, K.L. (2011). The relationship between early reading skills and speech and language performance in young children with cleft lip and palate. *Cleft Palate Craniofacial Journal*, 48(3), 301-311.
- Deepa, A. (2010). Restandardization of Kannada articulation test.. *Student Research at AIISH (Articles based on dissertation done at AIISH, Mysore), Vol. VIII, Part B,* 53-65.
- Deepthi, K.J. & Pushpavathi, M. (2017). An overview of vowel and consonant production by four Kannada speaking children preschool children with repaired cleft lip and palate. *Global Journal of Otolaryngology*, 9(3), 57-65.
- Durkin, M.S., Wang, W., Shrout, P.E., et al. (1995). Evaluation of the ten questions screen for childhood disability: Reliability and internal structure in different cultures. *Journal of Clinical Epidemiology*, 48, 657-666.
- Estrem, T & Broen, P.A. (1989). Early speech production of children with cleft palate. *Journal of Speech Hearing Research.* 32(1), 12-23.
- Goldman, R., Fristoe, M., & Williams, K. (2000). Goldman-Fristoe Test of Articulation--Second Edition: Supplemental Developmental Norms. Circle.
- Grunwell, P. (1981). The development of phonology: A descriptive profile. *First Language*, 2(6), 161–191.
- Harding, A & Grunwell, P. (1996). Characteristics of cleft palate speech. *International Journal of Language and Communication Disorders*, 31(4), 331-357.
- Hardin-Jones, M. A., Chapman, K. L., & Scherer, N. J. (2006, June 13).
- Early intervention in children with clef t palate. The ASHA Lead er,
- pp. 8–9, 32
- Hardin-Jones, M. A., Chapman, K. L., & Scherer, N. J. (2006) .Early intervention in children with cleft palate. *The ASHA Leader*, 8–9.
- McIntosh, B. & Dodd, B.J. (2008). Two-year-olds' phonological acquisition: Normative data. *International Journal of Speech Language Pathology*, 10(6), 460-469.
- Mcwilliams, B, Morris, H & Shelton, R. (1990). *Cleft Palate Speech*. PA: Decker, Philadelphia, USA.
- Morris, H.L. & Ozanne, A. (2003).Phonetic, phonological and language skills in children with a cleft palate. *Cleft Palate Craniofacial Journal*, 40: 460-470.
- Padmaja, B. (1988). Telugu articulation test. *Students research at AIISH*, University of Mysore, Mysore.
- Paul, R. & Jennings, P (1992). Phonological behavior in toddlers with slow expressive language development. *Journal of Speech Hearing Research,* 35 (1), 99-107.
- Pratima, S. (2009). Articulatory acquisition in typically developing native Kannada speaking children. *Students research at AIISH*, University of Mysore, Mysore.
- Rohini, H. (1989). Deep test of articulation in Kannada- Sentence form. *Students research at AIISH*, University of Mysore, Mysore.
- Scherer, N., D'Antonio. L.L., & McGahey, H. (2008). Early intervention for speech impairment in children with cleft lip and palate. *Cleft Palate Craniofacial Journal*, 45(1), 18-31.
- Shriberg, L.D. (1986). *PEPPER: Programs to examine phonetic and phonologic evaluation records*. Hillsdale, N.J: Lawrence Erlbaum.
- Shriberg, L.D., & Kwaitkowski, J. (1982). Phonological disorders III: A procedure for assessing severity of involvement. *Journal of Speech and Hearing Disorders,* 47, 256-270.
- Shriberg,L.D., Austin, D., Lewis, B.A., McSweeney, J.L., & Wilson, D.L. (1997).

The speech disorders classification system (SDCS): Extensions and lifespan reference data. *Journal of Speech Language and Hearing Research*, 40(4), 723-740.

- Smit, A., Hand, L., Freilinger, J., Bernthal, J. and Bird, A., 1990, The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders,* 55, 779–798.
- Upadhyaya, U.P. (2000). *Kannada Phonetic Reader*. Mysore: Central Institute of Indian Languages.
- Usha, D. (1986). Tamil articulation test. *Students research at AIISH*, University of Mysore, Mysore.

- Van Demark, D.R., Morris, H.L. & Vandehaar, C. (1979). Patterns of articulation abilities in speakers with cleft palate. *Cleft Palate Journal, 16*, 230-240.
- Venkatesan, S. (2011). *Socio Economic Status scale*: NIMH revised version. AIISH, Mysore.
- Williams, A.L. & Elbert, M. (2003). A prospective longitudinal study of phonological development in late talkers, *Journal of Language Speech Hearing Service Schools,* 34(2), 138-153.

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