Phonological Processes in Typically Developing Tamil Speaking Children

Radhakrishnan Chella Perumal, Vaidyanathan Raghunathan, Prakash Boominathan and Sreedevi N.

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Abstract

Aim of the study was to profile the type and frequency of occurrence of phonological processes in Tamil speaking children. 450 typically developing 2 to 5 year old Tamil speaking children participated in this study. Speech samples of these children were elicited using spontaneous picture naming task. Speech samples were then phonetically transcribed by a qualified speech language pathologist. Transcribed samples were analysed to determine the type and frequency of occurrence of phonological processes. Results of the study revealed occurrence of 15 different types of phonological processes. Frequency of occurrence of all the phonological processes declined as age increased. Most of the processes were suppressed by age of 3 years except cluster reduction and stopping of liquids which persisted beyond 3 years.

Key words: Phonological processes, typically developing, Tamil

Introduction

Speech Language Pathologists (SLPs) often encounter clinical dilemmas in process of diagnosing speech sound disorders and typical speech language development in children. Literature evidence and knowledge of speech sound acquisition and phonological error patterns guide SLPs in this decision making process. Knowledge of phonological pattern is important for SLPs to estimate if the development of phonological skills of children is in par with age or delayed. Phonological patterns are systematic errors in child's speech. These error patterns are commonly referred to as phonological processes. Phonological process is a systematic nature of child's simplifications and restructuring of adult's words (Macken & Ferguson, 1981).Estimating frequency of occurrence of these phonological processes through phonological process analysis is a recommended procedure for obtaining clear picture of phonological skills in children.

Normative data on phonological error patterns (Hodson & Paden, 1981; Stoel-Gammon & Dunn, 1985; Haelsig & Madison, 1986; Holm & Dodd, 1999; Dodd, Holm, Hua & Crosbie, 2003; Morrow, Goldstein, Gilhool & Paradis, 2014) have been reported in English and other European languages. In India, there have been attempts to explore the frequency of occurrence of phonological processes across different age groups from 2;6 to 6;6 years (Sunil,1998 in Kannada; Ranjan, 2001 in Hindi; Sameer, 1998 in Malayalam, Srilakshmi, 2005 in Telugu, Barathy, 2001; Nisthar, 2005; Sivapriya, Perumal & Savitha, 2009, Jisha, 2009; Venkatesh, Ramsankar, Nagaraja & Srinivasan., 2010; Kala & Lalitha, 2016 in Tamil). Majority of these studies have been carried out on typically developing children. Findings of studies related to Tamil language are described briefly in Table 1.

Table 1:

Studies on Phonological Processes in Tamil

Author	Age group (in years)	No. of subjects	Task and Test	Findings
Barathy (2001)	3;0 to 4;0	30	Picture naming , Test of Articulation in Tamil (TAT)	Unstressed syllable deletion, Nasal assimilation, Gliding, Metathesis, Initial consonant deletion, Backing, De-affrication and Affrication were observed in 3 year old children and Cluster Reduction, Epenthesis and Stopping persisted beyond 3 years of age.
Nisthar (2005)	2;6 to 5;0	54	Repetition and Conversation, TAT	Fronting, Backing, Cluster reduction, Assimilation, Initial consonant deletion, Stopping, Lateralization, Affrication and De-affrication were observed in this age group
Sivapriya, Perumal and Savitha (2009)	3;5 to 4;5	15	Answering to probe questions in simple sentence	Metathesis, Final consonant deletion, Gliding, Stopping were observed in this age group. Frequency of occurrence was more in 3;5- 3;11 year old children than in 4;0- 4;5 year old children
Jisha (2009)	4;0 to 6;0	20	Repetition and Narration of stories, TAT	Backing, Assimilation, Stopping and Lateralization were observed in 4 to 5 year old children and assimilation was suppressed in 5 to 6 year old children in repetition task. More processes such as Medial syllable deletion, Fronting, Cluster reduction and Affrication were evident in narration task than in repetition task
Venkatesh et al., (2010)	4;0 to 6;6	60	Picture Naming, TAT	Initial consonant deletion, Final consonant deletion, Syllable reduction, Cluster reduction, Affrication, Gliding of liquids, Fronting, De-affrication, Vowel assimilation and nasal assimilation were observed to be operating in the speech of monolingual children in the age group of 4-5 years. Gliding of liquids and Cluster reduction alone was observed in monolingual children above the age of five years
Kala and Lalitha (2016)	2;6 to 6;0	30	Repetition of words	37 processes were observed to be operating in speech of children. Most frequently operating processes were substitution processes followed by syllable structure and assimilatory processes

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Most of the phonological processes studies in Tamil and Indian languages have been attempted at master dissertation level with small sample size. Error patterns in these studies have also not been analysed in different context (different consonant-vowel combinations, sound positions, linguistic units (word/sentence/connected speech level), tasks (spontaneous/ imitation tasks)as these are important factor which can influence speech sound production. Data obtained from these studies have not been published and henceforth remain inaccessible for the SLPs. In the absence of such published studies in Indian languages, SLPs use the norms reported elsewhere as reference guide in their clinical practice. More over exploration of phonological error pattern is more relevant in the younger age group as early as 2 years of age as there has been increased parental concern on clarity of their children's speech at very young ages. No study till date has explored the error patterns in very young children between 2;0 and 2;5 years.

This study was planned to void this gap and to provide clinically useful information on phonological pattern in Tamil speaking children. The outcomes from this study will help SLPs to asses, analyse, diagnose and design intervention for articulatory/phonological disorder in Tamil speaking children.

Aim

To profile the type and frequency of occurrence of phonological processes in 2 to 5 year-old Tamil speaking children

Method

Current study was approved by Institutional Ethics Committee (Ref: IEC-NI/11/FEB/21/08) of Sri Ramachandra University, Chennai

Participants

450 typically developing Tamil speaking children ranging in the age between two and five years participated in this study. They were sub grouped in 6 months age interval, namely, a) 2;0-2;5 b) 2;6-2;11, c) 3;0 -3;5, d) 3;6-3;11, e) 4;0-4;5, f) 4;6-4;11. Seventy five children in each age group participated in the study.

All children were native speakers of Tamil and used Tamil as language of communication at home. However, they had exposure to English language at school. All children were screened for age adequate expressive and receptive language skills using Assessment of Language Development tool (Lakkanna, Venkatesh & Bhat, 2008). All participants in the study had normal cognition, hearing, motor and sensory development ascertained through informal assessment by the first author.

Procedure

Step 1: **Material Development**

Eighty-eight Tamil words were selected from school text/picture books considering the vocabulary levels of each age group. These words had twenty four consonants of Tamil (Refer table 2) in all possible contexts, i.e., word positions and consonant vowel combinations. Consonant [h] was not included as it is not used frequently in spoken form in Tamil language. Some words in the list assessed two target consonants. A professional artist was commissioned to draw the words as coloured pictures. The pictures were drawn in a 20 x 12 cm sized flash card using colour paints.

Table 2:

Consonants in Tamil Language (Consonants within brackets are allophones). (R. Vaidyanathan, Personal Communication, July 26, 2016)

	Bilabial	Dental	Alveolar	Retroflex	Palatal	Velar	Glottal
Stops	p [b]	t̪ [d̪]		ʈ [ɖ]		k [g]	
Nasal	m	[n̪]	n	ɳ	[ɲ]	[ŋ]	
Fricative			s				[h]
Affricate					ʧ [dz]		
Flap/Trill			r	(r̺)			
Laterals			l	ɭ	ʎ		
Semivowels	w				j		

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Step 2: Finalisation of Words through Familiarity Testing and Validation

The word list was subjected for familiarity testing on five children in each age group (Totally 30 children) to ensure that these pictures elicited intended target responses. The eighty eight pictures corresponding to the words in the list were shown one after the other to the participants and they were instructed to name the picture spontaneously. Prompts and cues were also provided to elicit the target word if children were unable to name the picture spontaneously.

Final Stimuli List

Forty three pictures which elicited the intended target word by 75% of the children after familiarity testing served as stimuli for picture naming task and the other words were discarded. Final list consisted of twenty four consonants with front, central and back vowels combinations (see Appendix).

Content Validity

These forty three words were further validated by two qualified SLPs for verifying suitability in terms of content and usage with participants. Content validity was estimated using Cohen kappa test of reliability. Kappa value of 0.64 indicated good reliability for naming material.

Table 3:

Content Validity for Naming Task Material

Material	Kappa Value	P value
Word list	0.64	0.00

Step 3: Data Collection

Consent was obtained from the parents/ caretakers of the participants for enrolment in the study. Data was collected from these participants at different settings such as schools, day care centres and paediatric clinics at Chennai city. Spontaneous picture naming task was used to elicit the speech samples. Prompts and cues were also provided to elicit the target word when children were unable to respond appropriately. The speech samples were audio recorded using Sony digital voice recorder ICD-UX533F in single sitting for each child.

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Speech sample elicitation using picture naming task took approximately 4 to 7 minutes per child.

Step 4: **Phonetic Transcription**

Recorded speech samples were phonetically transcribed by the investigator by listening to the samples using the headphones. To estimate reliability of transcription, eight speech samples were randomly picked from each group and were subjected for phonetic transcription by a qualified Speech Language Pathologist who was not related this study. Interclass correlation coefficient (ICC) was obtained to estimate transcription reliability. ICC value of 0.91 indicated high reliability between the transcribers.

Table 4:

Reliability of Transcription

Transcription Reliability	Interclass correlation coefficient (ICC)	95% confidence Interval		P value
		Lower bound	Upper bound	
Transcriber 1 and Transcriber 2	0.91	0.83	0.94	0.00

Step 5: **Data Analysis**

The investigator analysed the transcribed samples for occurrence of processes. Several other processes listed in the literature were consciously omitted in this study as they were deemed to be not applicable for Tamil language. For instance, final consonant deletion process is not applicable to Tamil, as in the spoken form words always end with a neutral vowel, and never with a consonant (though different in the written form). Unstressed syllable deletion is another example of a process that is not applicable to Tamil. Tamil does not have any stressed syllabic pattern, and syllabic stress is typically not distinctive in most Indian languages. Hence, only error patterns relevant to Tamil phonological system were considered for phonological process analysis in this study. Words in which these error patterns were found to be observed served as target stimuli for phonological processes analysis. Score of one was assigned for occurrence of process and zero for absence of process across age groups.

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Frequency of occurrence was estimated using percentage analysis. The percentage of occurrence of each process was determined using the following formula,

Number of occurrence of the process   x 100
Total number of possible occurrences of process in the list

Error patterns were identified as phonological processes only if it,

i)   was used in one or more words within the speech sample, and if a sound change had occurred even once (Lowe, 1994)

ii)   affected a class or sequence of sounds

Statistical Analysis

Mean percentage of occurrence of phonological processes within 2 to 2;5, 2;6 to 2;11, 3;0 to 3;5, 3;6 to 3;11, 4 to 4;5 and 4;6 to 4;11 age groups was determined using IBM.SPSS statistics software 23.0 version.

Results

Types of Phonological Processes

On analysis of the transcribed samples, 15 different types of processes/ phonological error patterns such as Initial Consonant Deletion, Medial Syllable Deletion, Cluster Reduction, Backing, Fronting, Stopping of Fricatives, Stopping of Liquids, Affrication, De affrication, Gliding of Liquids, Lateralization, Vocalization, Nasal assimilation, Velar assimilation, Labial assimilation were observed in the speech of children in the current study.

Frequency of Occurrence of Phonological Processes

Frequency of occurrence of the above mentioned 15 types of phonological processes are classified and presented under following three headings,

   I) Frequency of occurrence of syllable structure processes

   II) Frequency of occurrence of substitution processes

   III) Frequency of occurrence of assimilation processes

I. Frequency of Occurrence of Syllable Structure Processes

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Table 5:

Percentage of occurrence of Syllable Structure Process

Age (in years)	N	ICD	MSD	CR
2;0 to 2;5	75	23	16	41
2;6 to 2;11	75	10	03	20
3;0 to 3;5	75	01	01	09
3;6 to 3;11	75	01	00	07
4;0 to 4;5	75	00	00	04
4;6 to 4;11	75	00	00	02

ICD- Initial Consonant Deletion; MSD- Medial Syllable Deletion; CR- Cluster Reduction

It is clear from the Table 5 that, most frequently occurring process among the syllable structure category was cluster reduction. Frequency of occurrence of ICD and MSD was observed to drastically decline after three years indicating the fact that these processes disappears by age of three years. However cluster reduction was observed to persist in older groups with frequency of occurrence declining as factor of age.

II. Frequency of Occurrence of Substitution Processes

Table 6:

Percentage of Occurrence of Substitution Processes

Age	N	Back	Front	SoF	SoL	Aff	De Aff	GoL	Lat	Voc
2;0 to 2;5	75	13	33	23	22	22	39	15	09	06
2;6 to 2;11	75	09	17	11	10	20	22	06	09	02
3;0 to 3;5	75	04	07	01	13	06	02	03	07	00
3;6 to 3;11	75	02	03	01	07	05	02	02	03	00
4;0 to 4;5	75	02	02	01	06	04	02	01	03	00
4;6 to 4;11	75	01	02	00	06	02	01	01	01	00

Back-Backing; Front – Fronting; SoF- Stopping of Fricatives; SoL- Stopping of Liquids; Aff- Affrication; De Aff- De Affrication; GoL- Gliding of Liquids; Lat- Lateralization; Voc-Vocalization

In substitution process, it was observed that de-affrication was the most frequently occurring process followed by fronting, stopping of fricatives and stopping of liquids in the younger age groups 2;0 to 2;5 and 2;6 to 2;11 years. Table 6 reveal that de-affrication and stopping of fricatives were suppressed after three years. However, stopping of liquids persisted in the older age groups. Backing, gliding of liquids, lateralization and vocalizations were found to be occurring in lesser frequency in older age groups highlighting the fact that these processes disappear by age of 3 years.

III. Frequency of Occurrence of Assimilation Processes
Table 7:

Percentage of occurrence of Assimilation Processes

Age	N	Nasal	Velar	Labial
2;0 to 2;5	75	08	12	06
2;6 to 2;11	75	02	12	04
3;0 to 3;5	75	01	01	01
3;6 to 3;11	75	01	01	01
4;0 to 4;5	75	01	00	00
4;6 to 4;11	75	01	00	00

Analysis of the data revealed that velar assimilatory process appeared to be most frequently occurring process than nasal and labial assimilation in younger age groups. However, there was reduction in the frequency of occurrence of all the assimilatory processes after 3 years of age.

Discussion

Cluster reduction was found to occur in all the age groups and was persistent even above age of 4 yearsas observed in other Indian and Western studies (Venkatesh, et al.,

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2010;Sunil, 1998; Sameer, 1998; Ranjan, 1999; Barathy, 2001; Nisthar, 2005; Hodson & Paden, 1981; Haelsig & Madison,1987) Tamil language predominantly consists of geminated clusters, e.g., (*moʈʈai* 'bald',*laɖɖu* 'sweet') unlike typical blending of two phonemes as observed in other Indian languages and English, e.g., (**sk**u:l, **cl**ap). Individual analysis of data also revealed that errors were more observed on words such as*kattriko:l* 'scissor';*te:ŋga:*'coconut' than on words such as *moʈʈai* 'bald'; *pu:ʧʧi* 'insect' indicating that cluster reduction operated more on typical sound blends than in geminated forms. The declining pattern of Initial Consonant Deletion (ICD) and Medial Syllable Deletion (MSD) after 3 years was observed in Nisthar (2005); Barathy (2001) who also had reported ICD and MSD as initial processes to be eliminated before 3 years. Analysis of data indicated that only children in the younger age group below 3 years exhibited these errors. This could be because that words which were considered for analysis of these processes had semivowels *ja:nai* 'elephant', flap *ra:dza:* 'king' as initial consonant and *tavaɭai* 'frog'; *seruppu* *'footwear'* as medial syllable. Children in the younger age group found difficult to produce semivowels and laterals hence could have omitted these sounds during production. These errors were supressed by 3 years as more than 90% of children could produce these sounds correctly by 3 years.

Frequency of occurrence of de-affrication, e.g., dannal for *dzannal* 'window', stopping of fricatives(e.g.,. ti:ppu for *si:ppu* 'comb', stopping of liquids, e.g., madam *for maram* 'tree*',* affrication, e.g.,. penʧil for *pensil* 'pencil' and gliding of liquids, e.g.,. taja for *tala* 'head') was more in younger age groups 2;0 to 2;5 and 2;6 to 2;11 years. This could be due to delayed acquisition of affricates, fricative, laterals, flaps and trills. These processes were eventually suppressed after complete acquisition of these sounds. Persistence of stopping of liquids and lateralization in the ages above 3 years highlighted the fact that flaps, trills and laterals were still being acquired by the children. Stopping of liquids was more on non-initial position when compared to initial position of words, e.g., *puɽa*: 'dove' versus *r*abbar 'eraser'. Sounds were lateralized more especially when preceded by lateral sounds over non lateral sounds, e.g., *la:ri* 'lorry' versus *k*arat 'carrot'. With respect to placement, backing was eliminated by 3 years and persistence of fronting process beyond 3 years indicated that some mid sounds were not yet acquired by age of 3 years. Findings of this study are in concordance with Sameer (1998); Ranjan (1999); Barathy (2001); Nisthar (2005)

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and Venkatesh, et al., (2010) who reported elimination of backing, de affrication by three years and persistence of fronting, stopping of liquids beyond three years.

Assimilatory processes were rarely observed in children in the current study as reported in other studies (Barathy, 2001; Haelsig & Madison, 1987). Among the assimilatory processes, greater number of children in younger age group below 3 years exhibited velar assimilatory process (e.g.,. ka:kkar for *ḍa:kʈar* 'doctor' gaŋgan for *raŋgan* 'name of a person') when compared to nasal and labial assimilation. This could have been due to the presence of retroflex stop [ḍ] and [r] in the words considered for analysis of this process. Frequency of occurrence of retroflex stops [ḍ] is less than other stops and moreover acquisition of [r] is delayed. This would have influenced the occurrence of this process in the younger age group.

In summary, frequency of occurrence of processes declined as age increased. Most of the processes were suppressed by age of 3 years except cluster reduction and stopping of liquids which persisted beyond 3 years in the current study. While this study has provided clinically relevant information, however the findings of this study needs to be carefully interpreted considering the task, material and criteria used for phonological process analysis. Efforts could be taken in future to analyse speech at a connected speech level which would provide clear information on the phonological error patterns as it mimics the natural speaking situations. Future research could also attempt on longitudinal exploration of data in children to obtain accurate information on developmental pattern.

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Appendix
word list

S.No	Words	words (IPA)
1	கண்	kaɳ
2	காது	ka:dɨ
3	கோழி	ko:ɭi
4	டாக்டர்	da:kʈʈar
5	கத்தி	katti
6	கதவு	kadavɨ
7	கத்ரி	katri
8	நாக்கு	na:kkɨ
9	குதிரை	kudirai
10	கேரட்	keraʈ
11	கப்பல்	kappal
12	தேங்கா	te:ŋga:
13	கை	Kai
14	சிங்கம்	siŋgam
15	சாவி	sa:vi
16	சீப்பு	si:ppɨ
17	சோப்பு	so:ppɨ
18	செருப்பு	seruppɨ
19	மஞ்சள்	maɳdzaʎ
20	தட்டு	taʈʈɨ
21	பூட்டு	pu:ʈʈɨ
22	லட்டு	laɖɖɨ
23	மொட்ட	moʈʈa
24	தலை	tala
25	தவளை	tawaʎa
26	தொப்பி	toppi
27	பாம்பு	pa:mbɨ
28	பல்லி	balli
29	பென்சில்	pensil
30	பலூன்	balu:n
31	பூனை	pu:na
32	பேனா	pe:na:
33	வீடு	wi:ɖu
34	பூச்சி	pu:ʧi
35	மாடு	ma:ɖɨ
36	மரம்	maram
37	மீன்	mi:n
38	மழை	maɻa
39	யானை	ja:na
40	ரப்பர்	rabbar
41	லாரி	la:ri
42	ஜன்னல்	dzannal
43	புறா	puɾa:

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Radhakrishnan Chella Perumal, M.Sc. (Speech and Hearing)
Corresponding Author
Reader
Department of Speech Language and Hearing Sciences
Sri Ramachandra University
Porur, Chennai 600 116
Tamilnadu
India
rcperumal@sriramachandra.edu.in

Vaidyanathan Raghunathan, Ph.D. (Linguistics)
Visiting professor (Linguistics)
Department of Speech Language and Hearing Sciences
Sri Ramachandra University
Porur, Chennai 600 116
Tamilnadu
India
raguvai@yahoo.com

Prakash Boominathan, Ph.D. (Speech Language and Hearing Sciences)
Professor
Department of Speech Language and Hearing Sciences
Sri Ramachandra University
Porur, Chennai 600 116
Tamilnadu
India
prakash_boominathan@sriramachandra.edu.in

Sreedevi, N., Ph.D. (Speech and Hearing)
Reader and Head
Department of Clinical Services
All India Institute of Speech and Hearing
Mysore 570 006
Karnataka, India sreedeviaiish@gmail.com

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