SPEECH SOUND DEVELOPMENT IN TYPICALLY DEVELOPING MALAYALAM - ENGLISH SIMULTANEOUS BILINGUAL CHILDREN

NEELIMA N

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Speech Language Pathology

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ALL INDIA INSTITUTE OF SPEECH AND HEARING,

MANASAGANGOTHRI, MYSURU-570006

JUNE, 2026

CERTIFICATE

This is to certify that this dissertation entitled **"Speech Sound Development in Typically Developing Malayalam-English Simultaneous Bilingual Children"** is a bonafide work submitted as part of fulfilment of the degree of Master of Science (Speech Language Pathology) of the student with Registration Number P01II24S123028. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

M. Pushpavathi

Mysuru
8th June, 2026

Dr. M. Pushpavathi

Director
All India Institute of Speech and Hearing
Manasagangothri, Mysuru-570 006

CERTIFICATE

This is to certify that this dissertation entitled **"Speech Sound Development in Typically Developing Malayalam-English Simultaneous Bilingual Children"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
June, 2026

N. Sreedevi 3/6/2026.

Dr. N Sreedevi
Professor of Speech Sciences
All India Institute of Speech and Hearing
Manasagangothri
Mysuru-570 006

डॉ. एन. श्रीदेवी / Dr. N. Sreedevi
प्रोफेसर ऑफ स्पीच साइन्स / Professor of Speech Sciences
विभाग / Department of Speech-Language Sciences
All India Institute of Speech and Hearing
Manasagangothri
मैसूरु / Mysuru-570 006

DECLARATION

This is to certify that this dissertation entitled **Speech Sound Development in Typically Developing Malayalam-English Simultaneous Bilingual Children** is the result of my own study under the guidance of Dr. N Sreedevi., Professor of Speech Sciences Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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Registration No:
P01II24S123028

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LIST OF FREQUENTLY USED ABBREVIATIONS

CV accuracy - Consonant/Vowel accuracy

GFTA-3 – Goldman-Fristoe Test of Articulation-3

MAT-R – Malayalam Articulation Test-Revised

PCC-R – Percentage of Consonants Correct

PWC- Proportion of Whole Word Correctness

SODA- Substitution, Omission, Distortion, Addition

WWA- Whole Word Accuracy

ABSTRACT

Simultaneous bilingualism involves acquiring two languages since birth or within the first few years of life. Speech sound development in simultaneous bilingual children may differ from monolinguals due to the cross-linguistic interaction between the two phonological systems and understanding this is important to differentiate language differences from speech sound disorders to avoid misdiagnosis. However, despite India being a multilingual country, studies on bilingual speech sound development are limited. Therefore, the present study aimed to investigate the speech sound development pattern and accuracy of typically developing Malayalam-English simultaneous bilingual children in the age range of 4-5 years across languages and age groups. The study included a total of 16 Malayalam-English simultaneous bilinguals in two subgroups (>4;0 to ≤ 4;6 and >4;6 to ≤ 5;0 years). Speech samples were collected using articulation tests and story narration in both languages. Phoneme-wise analysis and four articulatory outcome measures (CV accuracy, WWA with PWC, PCC-R & percent speech intelligibility) were extracted to compare performance across the 2 languages and age groups. Results revealed that all vowels and diphthongs were correctly produced by all participants by >4;0 to ≤ 4;6 years and the correct production of consonants and clusters increased with age in both languages. Statistical tests were applied to compare speech sound accuracy across languages and age groups. Overall, the study indicated that speech sound accuracy of Malayalam-English simultaneous bilinguals improved with age and a better phonological performance was found in English for all the outcome measures compared to Malayalam.

Keywords: Simultaneous bilingualism, Speech sound development, Speech sound accuracy, Malayalam – English bilingual children.

Chapter I

INTRODUCTION

Speech sound development is a crucial milestone by which a child perceives, processes, produces and refines the sounds of their language. The development of speech begins even before the first word production, i.e., since birth cry. Infants go through a series of crucial developmental stages by the time they achieve adult-like words and intelligibility. Children typically transition from producing a limited inventory of sounds to mastering each speech sound, majorly consonants and vowels, by the time they are entering school, i.e., between 4 and 5 years (McLeod et al., 2015). Typical speech and language development involves a complex pattern where new skills build upon the already established ones. Speech sound development follows a complex trajectory that involves sensorimotor coordination along with cognitive processing for intelligible speech production (McLeod & Crowe, 2018). This process is largely predictable, with established developmental norms indicating the typical age ranges for the acquisition of specific sounds in various languages (Priester et al., 2011). Speech sound accuracy measures how correctly an individual produces sounds of their language compared to adult target which is an important indicator of speech sound development (Preston et al., 2011)

Extensive research has been done on speech sound development of children in various languages globally to determine individual sound mastery in specific groups of children. These studies revealed a global trend where vowels are acquired first by 2-3 years of age followed by consonants such as stops, vowels, glides etc. Complex sounds that need motoric precision to produce are acquired later, such as fricatives, affricates, consonant clusters, etc. achieving mastery approximately at 5-6 years of

age. (Arlt & Goodban, 1976; Deepa & Savithri, 2010; Kilminster & Laird, 1978; McLeod & Crowe, 2018; Perumal, 2019; Prathima & Sreedevi, 2009; Priester et al., 2011; Templin, 1957, etc.) Nonetheless, individual differences and exposure to multiple languages, along with environmental factors, give rise to variations in acquisition patterns, necessitating investigations of speech sound development in diverse linguistic contexts (Gildersleeve-Neumann et al., 2008).

Bilingualism is the regular use of more than one language, and thus bilinguals are people who need and use more than one language in their everyday lives (Grosjean, 2021). Bilingualism, to simply put, is the knowledge and use of at least two languages. The language learned first becomes L1 and the one learned second becomes L2. According to the age of acquisition, there are mainly two types of bilingualism. Simultaneous acquisition of two languages occurs when children are exposed to both languages from a very early age, sometimes as a result of each parent speaking a different language with the child or both parents speaking one language and a caregiver speaking another language with the child. Meanwhile, sequential acquisition occurs when a child begins to learn a second language after the first language is at least partly established (Tabors, 2008). The former is referred to as simultaneous bilingualism and the latter is referred to as “sequential” or “successive” bilingualism. The arbitrary cutoff age for this distinction is commonly considered 3 years, which is supported by neuroimaging research on bilingual adults that showed a non-native-like pattern of activity in response to a new language acquired after 3 years of age (Perani et al., 2003). De Houwer (2009) used the term “Bilingual first language acquisition (BFLA)” for those who are exposed to both languages since birth. The significant rise of Bi/Multilingualism since an early age as a global trend

presses the need for understanding development of speech sounds in the context of exposure to multiple languages.

Hence, speech sound development in bilingual children is a developing area of interest for researchers across the world. Various studies have been done to understand the influence of bilingualism on the development of speech sounds in specific groups of children, especially in languages such as Spanish, Mandarin, Korean etc. However, majority of the studies have focused upon the sequential bilingual children rather than simultaneous bilingual children. One of the few studies on simultaneous bilinguals to compare articulation and phonological pattern in both languages was done by Brice et al (2009). They considered 16 Spanish-English simultaneous bilingual children in the age range of 4-5 years and administered English and Spanish articulation and phonology tests. Comparing the manner of articulation, two sound categories showed significant differences in production: plosives and glides/liquids with English sounds being more accurate in production. Similarly, two phonological patterns, stopping and velar fronting also showed significant differences among languages. Interference between languages was evident in the articulations and phonological patterns. Similar findings about the interference or interaction between languages, which led to acceleration or deceleration in the phonological development and phonological accuracy of bilingual children, can be seen across various studies (Anderson, 2004; Fabiano-Smith & Barlow, 2010; Fabiano-Smith & Goldstein, 2010; Gildersleeve-Neumann et al., 2008). Despite this evidence, studies on bilingual speech sound development in the Indian context are almost nonexistent considering India is a multilingual country.

India is well known for its linguistic diversity, with the 2011 census recognizing 1,369 rationalized mother tongues, which are further grouped to total 121

languages spoken throughout the nation. This diversity offers a unique opportunity for Indians to be bilinguals or multilinguals. As per the 2011 census, 26.02% of the population are bilinguals in India, whereas 7% are multilinguals. In recent years, this percentage has been estimated to be increased further. Recent data by Nagarajan (2018) shows that 52% of the youth between ages 20-24 years are bilingual in India. These changes can be primarily attributed to globalization arising as a norm, which provides vast opportunities to learn new languages for occupational, educational and personal purposes. Along with this, the advancement in technology and early and easy availability of resources also contribute to which bi/multilingualism arising as a way of life for Indians.

Kerala, a southern state in India, has been considered the most literate state in India for decades, with an effective literacy rate of 95.3% as per Periodic Labour force Survey in 2023-24. Even though Malayalam (a Dravidian language) is spoken as a first language in Kerala, Malayalis are exposed to multiple languages because of their long history of migrations both in and outside India, cultural contacts and education. Malayalam is also the official language of the Union territories Lakshadweep and Mahe. A large number of studies have researched the acquisition of speech sounds in Malayalam and English for both typically developing and disordered populations. Neenu et al. (2011) studied the typical age for Malayalam phonological development across age groups. They found that most vowels are mastered early, between 3.0 and 3.3 years of age, while /u/ and /uː/ are mastered later, by 4.0-4.3 years according to 100% acquisition criteria. For consonants, the acquisition order is more staggered: unaspirated bilabials, dentals, and velars are mastered by 3.0-3.3 years; labiodentals, alveolars, palatals (except /h/ and /d̪/), and aspirated sounds are mastered by 4.0-4.3 years; and retroflex and all palatals are mastered by 5.0-5.3 years.

Notably, the singleton sound /h/ is particularly difficult, with 100% mastery not achieved by the age of six. However, Divya and Sreedevi (2010) suggested an earlier mastery of sounds where all vowels achieve 90% acquisition criteria by 2.9 years of age. Furthermore, most of the consonants except liquids and fricatives were acquired by 3 years. Recently, Asin et al. (2024) reported consonant that clusters were acquired as early as two years of age in Malayalam.

The West-Germanic language, English, is the most spoken language in the world with more than 1.5 billion total speakers, primarily because of its widespread use as a second language (Kortmann, 2024). Numerous studies have explored speech sound development of English-speaking children since 1930's. (Arlt & Goodban, 1976; Dyson, 1988; Kilminster & Laird, 1978; Robb & Bleile, 1994: Templin, 1957; Wellman et al.,1931 etc.). Crowe and McLeod (2020) investigated the English consonant acquisition of children in the US by reviewing 15 articles. The findings showed that all plosives, nasals and glides were acquired by 3;11 years, all affricates by 4;11 years, all liquids by 5;11 years and all fricatives by 6;11 years.

Even though several studies explored speech sound development in monolinguals, bilingual speech sound development is an underexplored area in the Indian context, despite the increasing prevalence of bilingualism in India. The lack of established data for phonological development and phonological accuracy in bilingual children impedes accurate clinical assessment by speech-language pathologists. The present study is planned to provide preliminary data on bilingual speech sound development and accuracy in Malayalam-English bilingual children.

Need of the study

A global language such as English is widely used in Kerala as a second language, mostly in schools and colleges for communication. English is taught as

early as in preschools in most regions in Kerala, along with extensive exposure to it through highly educated parents as a part of daily conversations. Most children are exposed to both languages before the age of 3 years, which classifies them as simultaneous bilinguals. The bilingual context creates a unique language environment with interaction between two distinct phonological systems and accurate speech sound development is foundational for effective communication and literacy skills in both languages. Hence, the speech sound development and accuracy in children who are using both Malayalam and English for everyday communication needs to be studied for addressing the influence of bilingualism on typical speech sound development in children.

There is a notable gap in the empirical research specifically addressing typical speech sound development in Malayalam-English bilingual children. The existing studies predominantly focus on speech sound development in monolingual children, necessitating further exploration of speech sound development and speech sound accuracy in bilingual children of these languages.

Malayalam and English have notable differences in their phonological inventories and phonotactic constraints. Investigating speech sound development in bilingual children can uncover patterns of cross-linguistic influence, transfer, or interference, which are crucial for designing effective bilingual language support and therapeutic strategies. Sunny and Kumaraswami (2015) attempted to analyze the phonetic inventory in Malayalam-English bilingual children in the age range of 3-5 years. They found that the acquisition of vowel production was completed by 3 years of age and children produced most of the sounds at a younger age compared to earlier studies. However, this study failed to explain the influence of the bilingual factor in the development of phonetic inventory of these children. This indicates the need for

more recent and reliable data on the speech sound development of typically developing bilingual children.

Knowledge of the speech sound developmental pattern in typically developing children is an important aspect for speech-language pathologists for the differential diagnosis between typical speech sound patterns and speech sound errors. A precise analysis of speech sound accuracy is vital in the early diagnosis of speech sound disorders. With the rapidly developing trend of early exposure to English through multimedia and schools, the development of speech sound patterns and accurate speech sound production in Malayalam can be greatly influenced by English. Therefore, understanding the age of speech sound acquisition along with speech sound accuracy in bilingual children is an immediate need in the clinical and research domains.

Speech-language pathologists in India very often work with children from bilingual or multilingual backgrounds but often lack evidence-based guidelines for such population. This suggests an immediate need for well-researched studies in all domains of language, especially on speech sound development in bilingual children. The current study will address this research gap by assessing speech sound development in Malayalam-English bilingual children giving future directions for similar studies in other Indian languages.

Aim of the study

The present study aimed to investigate the speech sound development of typically developing simultaneous bilingual Malayalam (L1)-English (L2) speaking children in the age range of 4-5 years.

Objectives of the study

1. To investigate the speech sound development pattern in L1 (Malayalam) and L2 (English) in typically developing simultaneous bilingual children.
2. To investigate the speech sound accuracy in L1 (Malayalam) and L2 (English) in typically developing simultaneous bilingual children based on the following four articulatory outcome measures
    - Consonant - Vowel (CV) Accuracy
    - Whole word accuracy (WWA) with Proportion of Whole-Word Correctness (PWC)
    - Percentage of Consonants Correct - Revised (PCC-R)
    - Percentage of Speech intelligibility
3. To compare the above-mentioned articulatory outcome measures between L1 and L2 of the participants within age groups.
4. To compare the above-mentioned articulatory outcome measures between age groups for L1 and L2 of the participants

Chapter II

REVIEW OF LITERATURE

Speech sound development is a complex process that involves dynamic interplay of biological maturation and cognitive growth. Children acquire speech sounds in a fairly predictable pattern, typically transitioning from universal phonetic perception to language-specific mastery, suppressing phonological processes to achieve adult like intelligibility. However, individualistic variations can be observed for the age of onset of these sounds.

Extensive research on monolingual children has established norms for speech sound acquisition, including the developmental trajectory of phonemes, phonological processes, and age-related milestones. However, bilingual children often exhibit a distinct pattern of development which is influenced by cross-linguistic interaction, exposure to language and usage variability etc. Phenomena such as transfer, acceleration and delay influence the pattern of acquisition distinct from that of monolinguals. Therefore, understanding the speech sound development in bilingual children is essential for accurate differentiation between typical development patterns and speech sound disorders, as well as for planning appropriate assessments and intervention. The literature review will be discussed under the following headings:

2.1 Speech sound development and related factors

2.2 Speech sound development in typically developing monolingual children

2.3 Bilingualism and language development in children

2.4 Speech sound development in typically developing bilingual children

2.5. Comparison of Malayalam and English phonology.

2.1. Speech sound development and related factors

Speech sound development is a crucial and dynamic process involving gradual acquisition of phonology of a child's native language, progressing from rudimentary vocalizations to sophisticated production of intelligible speech (Ferguson & Farwell, 2013). The speech sound development not only depends on the exposure to ambient languages, but also on child's anatomical and physiological maturation with respect to speech perception and production. Also, development of cognition is crucial for speech sound development, such as attention, memory, lexical access, etc. (Stemberger & Bernhardt, 2022).

A child progresses from first cries at birth to adult-like production of vowels, consonants, syllable structures and prosody over the years, ultimately achieving intelligible speech. Thus, speech sound development occurs in a predictable pattern, despite the individualistic variations during development. According to Bernthal et al (2016), there are four phases of speech sound development.

Phase 1: Laying foundations for speech (birth to 1 year): A transition from reflexive vocalizations to canonical babbling occurs and as children near their first birthday, they utter the first word which is assisted by synchronized development and maturation of anatomical and physiological structures, neurological pathways and perceptual abilities.

Phase 2: Transitioning from words to speech (1 to 2 years): As children mature towards age two, their consonant inventory expands significantly, transitioning from an average of four consonants at age one to approximately fifteen by the age of two and they also produce small vocabulary around 50 words in simplified phonological structures.

Phase 3: The growth of inventory (2 to 5 years): Children learn to produce majority of the speech sounds and syllable structures in addition to grammatical and syntactic development with a sequential mastery of early, middle and late speech sounds. While basic vowel systems are generally stabilized by 3 years of age, accuracy of consonants and clusters continues to refine itself.

Phase 4: Mastery of speech and literacy (5+ years): Sophistication of timing, prosody and accuracy in producing polysyllabic words and consonant clusters occur in this period. Along with the spoken domain, sounds are also conveyed through writing.

This acquisition of speech sounds is a multifactorial process governed by various intrinsic and extrinsic variables. These include biological and developmental variables, cognitive-linguistic factors, motoric capabilities and auditory perception, environmental factors and individual variability (Bernthal et al., 2016; Irwin, 1952; Torres et al., 2020).

Older children show more accurate production of speech sounds compared to younger children which is assisted by the development both gross and fine motor skills suggesting a positive correlation between refinement of articulatory skills and age (Dodd et al., 2003). Various earlier investigations indicate that children's articulatory and phonological skills continue to refine until about 8 years when most of the typically developing children have mastered nearly all the sounds in adult speech. (Bernthal et al., 2016). Timely acquisition of speech is necessary for children to maintain meaningful engagement in the world.

Smit et al (1990) found a different age of acquisition for girls and boys for 11 sounds, especially at 4;0, 4;6 and 5;0 years of age. Dodd et al. (2003) found no difference in gender in speech sound acquisition between 3;0 and 5;5 years, yet girls

outperformed boys in the older age groups i.e., 5;6-6;11 years. However, these differences disappear as children grow older (Bernthal et al., 2016).

Children with hearing impairment shows reduced phoneme discrimination, leading to poor speech production outcomes (Robbins et al., 1991), while typically developing children performed better in auditory perception tasks compared to children with speech sound disorder (Edwards et al., 2002). Similarly, structural and functional irregularities such as cleft lip and palate, childhood apraxia of speech or dysarthria etc. significantly disrupts the usual developmental trajectory of speech sounds (Kummer, 2020; Shriberg et al., 2019).

Two-year old children with advanced vocabulary showed superior phonological skills compared to their age-matched peers (Smith et al., 2006), revealing the connection of speech and language development during early language acquisition. Individual variations account for different rates of development, word repetition consistency and styles of learning (Bernthal et al., 2016). Additionally, Maggu et al. (2021) revealed a surge in the development of simple and complex sounds following exposure to complex inputs.

Typically developing children exhibit better phonological awareness development than children with omissions and atypical speech errors (Mann & Foy, 2007; Brosseau-Lapré & Roepke, 2019). Articulation skills of individuals with cognitive impairment are found to be delayed and generally similar to younger typically developing children and difficulties in working memory capacity may slow down suppression of phonological processes (Bernthal et al., 2016; Torrington Eaton & Ratner, 2016).

Contradicting findings have emerged on environmental factors such as socio-economic status, with older studies indicated the performance of high socio-economic

status to be better (Templin, 1957) while newer studies found no correlation (Smit et al., 1990). High-frequency input strengthens the phonological loop in working memory, facilitating easier transition to motor production (Storkel, 2001).

Further, the global increase in bilingualism has profound implications for understanding speech sound acquisition. Hambly et al (2013) reviewed the influence of bilingualism on speech production and suggested that monolingual and bilingual children develop speech sounds differently in terms of rate and patterns of error. It was evident that both positive and negative transfer occurs in bilingual children shaping the final phonetic output.

The age of acquisition represents the point at which these diverse internal and external factors typically converge to produce adult like speech. Within this multifactorial framework, several authors across various languages have tried to determine the typical speech sound development in children since the last century.

2.2. Speech sound development in typically developing monolingual children

The speech sound acquisition starts with simple vowels and then progresses into different phonemes and clusters. Mastery in the production of vowels, consonants and clusters is needed for the outcome of intelligible speech. The process is assisted by exposure to languages and biological maturation.

Typically, English speaking children are about 75% understandable by age three, 90% understandable by age four and fully understandable by age five, revealing a progressive development of articulation (Pena-Brooks & Hegde, 2007). Speech sound development in English-speaking children has always been a field of interest for several researchers since the start of the 20th century (Wellman et al.,1931; Templin, 1957; Arlt& Goodman, 1976; Kilminter & Laird 1978; Dyson, 1988; Robb & Bleile, 1994). These studies revealed a predictable pattern of speech sound

development. The vowels and diphthongs are typically acquired and mastered by 3 years of age, which is a finding consistent across studies in various languages. The age levels for the speech sound development in years according to various classic studies in English are listed in Table 2.1

Table 2.1

Speech sound development in English (in years)

Speech sounds	Wellman 1931 75%*	Templin 1957 75%*	Sanders 1972 75%*	Arlt & Goodman 1976 75%*	Kilminter& Laird, 1978 75%*	Irwin et al 1983 90%	Smit et al 1990 75%*	Dodd et al 2003 90%*
/m/	3	3	<2	3	3	1.5	3	3.0-3.5
/n/	3	3	2	3	3	2	3	3.0-3.5
/h/	3	3	<2	3	3	2	3	3.0-3.5
/p/	4	3	<2	3	3	3	3	3.0-3.5
/f/	3	3	3	3	3.6	3	3	3.0-3.5
/w/	3	3	<2	3	3	2	3	3.6-3.11
/b/	3	4	<2	3	3	1.5	3	3.0-3.5
/ŋ/	–	3	2	3	3	3	7-9	3.0-3.5
/j/	4	3 ½	3		3	3	4-5	3.6-3.11
/k/	4	4	2	3	3	3	3.5	3.0-3.5
/g/	4	4	2	3	3	3	3.5-4	3.0-3.5
/l/	4	6	3	4	4	3	5-7	3.6-3.11
/d/	5	4	2	3	3	4	3-3.5	3.0-3.5
/t/	5	6	2	3	3	3	3.5-4	3.0-3.5
/s/	5	4½	3	4	4.6	3	7-9	3.0-3.5
/r/	5	4	3	5	5	3	8	
/ʧ/	5	4½	4	4	4	4	6-7	4.0-4.5
/v/	5	6	4	3½	6	3.5	5.5	3.0-3.5
/z/	5	7	4	4	4.6	3	7-9	3.0-3.5
/ʒ/	6	7	6	4	4.6	3		4.0-4.5
/θ/		6	5	5	8.6	4	6-8	>7.0
/ʃ/		4½	4	4½	4	3	5	5.0-5.5

Note: Adapted from Table 5.4 in *Articulatory and Phonological Impairments: A Clinical Focus* by Bauman-Waengler (2012), '- 'indicates sounds not acquired at specific age levels. Blank space indicates sounds not tested

These studies reveal a consistent trajectory for the sequence of mastering sounds in monolingual children; meanwhile, a shift in the articulatory proficiency is

reflected over years, where children acquire speech sounds earlier than previously established norms.

Holm et al (2022) carried out a preliminary study by comparing speech sample of 99 neurotypical Australian children in the age range of 3;0-3;8 years to previously established norms. Phonetic repertoire was identical to the DEAP norm in 2002, for ages 3;0-3;5 years. While a few later developing sounds (/z/, /ʧ/, /ʃ/) were still emerging in children's phone repertoires, overall development showed expected patterns. The findings reflected on how children's language learning environments are changing and potentially influencing speech development.

Crowe and McLeod (2020) conducted a systematic review of 15 cross-sectional studies to acquire knowledge on English speech sound development of children in the United States. According to 90% criteria, sounds were classified into early 13 (/b, n, m, p, h, w, d, ɡ,k, f, t, ŋ, j/), middle 7 (/v, ʤ,s,ʧ, l, ʃ, z/) and late 4 (/ɹ,ð,ʒ, θ/). These sounds were developed between 2;0-3;11 years, 4;0-4;11 years and 5;0-6;11 years respectively. This indicates that plosives, nasals and glides were the first sounds to be acquired followed by affricates, liquids and fricatives.

Similar patterns of acquisition are evident across studies from several languages across the world. In a 2018 cross-linguistic review by McLeod and Crowe, they referred to 60 articles describing 64 consonant acquisitions in 27 languages. The languages included Arabic, Cantonese, Dutch, English, French, German, Italian, Japanese, Korean, Portuguese, etc. Across the studies for Japanese consonant acquisition, it was identified that the nasals, plosives, and approximants typically were acquired earlier than flaps and most fricatives. In Korean, nasals, plosives, and affricates typically were acquired earlier than the lateral and the fricative /s/. Also, acquisition of consonants produced with the lips, pharynx, and posterior tongue was

found earlier than consonants articulated with the anterior tongue. However, there was an interaction between place and manner for both Japanese and Korean. A similar pattern of acquisition was found even in Spanish. Nasals, plosives, approximants, and laterals typically were acquired earlier than flaps and some fricatives.

Li and To (2017) analyzed and reviewed 12 articles on speech sound acquisition in Mandarin and observed that the consonant acquisition was majorly consistent with the general developmental trend in other languages. Plosives and nasals were acquired by 3;0 years of age with the exception of a few aspirated plosives which were acquired by 4;0 years. Fricatives and affricates were developed between the age of 3;0 and 5;0 years, while retroflex sounds found to be difficult and later developing; the acquisition was active even at the ages of 6;0 and 7;0 years.

Priester et al. (2011) reviewed and compared the normative data of British English and Dutch speech sound development in young children. Vowels and consonants were mastered by the age of three and four years respectively, except /s/ and /r/. Most consonant clusters in English were typically mastered between 5 and 6-8 years of age (Dodd, 2003) whereas in Dutch, the acquisition extended up to 10 years of age in some cases (Stes, 1977). Priester et al. (2011) inferred that these differences could stem from linguistic variabilities. However, recent studies reflect a much earlier acquisition of phonemes (Van Haaften et al., 2020).

Van Haaften et al. (2020) studied Dutch-speaking children aged 2;0-6;11 years and found that vowel acquisition was completed by the age of 3;4 years whereas consonant inventory was established later by acquiring syllable initial consonants except /v/, /z/ and /r/ by 3;7 years and all syllable final consonants by 4;4 years. Additionally, the findings indicated that the majority of syllable structures were mastered by 4;7 years of age.

Jimenez (1987) observed more variability in the acquisition of later developing phonemes in a study on 120 Hispanic children from Mexico in the age range of 3;0-5;7 years analyzing acquisition of Spanish consonants and found that most of the consonants, including plosives, nasals, trills, fricatives and affricates except /s/ and /r̄/ were mastered by 5 years of age based on 90% acquisition criteria. /s/ was mastered by 5;7 years while /r̄/ was acquired but yet to be fully mastered even after this age.

International studies outline a broadly similar trends of speech sound development, regardless of the phonetic variations among languages. Most of the sounds were fully acquired by 3-4 years of age, while later developing sounds such as fricative, affricates and consonant clusters may continue to be mastered until approximately by 5 years. Meanwhile, Indian languages introduce additional demands on phonology such as retroflex and aspiration.

2.2.1 Speech sound development in Indian monolingual children

Several studies have explored speech sound development in different Indian languages (Banik & Karanth, 1988 in Bengali; Banu, 1977 in Kannada; Maya & Savithri, 1990; Neenu and Sreedevi, 2011 in Malayalam; Padmaja & Karanth, 1988 in Telugu; Prathima & Sreedevi, 2009 in Kannada; Usha, 1986 in Tamil; Vipina and Sreedevi, 2011; Vrinda and Sreedevi, 2011 in Malayalam). These studies have consistently shown that speech sound development follows the same pattern as English and other global languages; however, an earlier acquisition of most of the phonemes in the Indian context has been evident. The age levels for the speech sound development in years according to previous studies across various Indian languages are listed in Table 2.2.

Table 2.2

Speech sound development in various Indian languages (in years)

Speech sounds	Tasneem Banu& Ratna, 1977 (Kannada) *75%	Prathima & Sreedevi, 2009 (Kannada) *90%	Padmaja & Karanth, 1988 (Telugu) *75%	Banik & Karanth, 1988 (Bengali) *90%	Usha & Karanth, 1986 (Tamil) *75%
/m/	3	3-3.6	2.6	2.5	3
/n/	3	3-3.6	2.6	2.5	3
/ŋ/	-	-	-	2.5	-
/p/	3	3-3.6	2.6	2.5	3
/f/	-	-	2.9	-	-
/h/	-	-	2.9	3	-
/k/	3	3-3.6	2.6	2.7	3
/b/	3	3-3.6	2.6	2.5	3
/d/	3.6	3-3.6	2.6	3	3
/g/	3	3-3.6	2.6	3	3
/r/	4.6	-	3.9	4	-
/s/	3	3-3.6	3.3	-	6
/ʃ/	5.1	3.6-4	3.6	3	3
/ʧ/	3.7	3-3.6	2.6	3	3
/t/	-	3-3.6	2.6	3	3
/v/	-	3-3.6	2.6	-	3
/l/	3	3-3.6	2.6	3	3
/j/	3	3-3.6	2.6	3	3

Note: * Indicate acquisition criteria of sounds '- 'indicates sounds not acquired at specific age levels. Blank space indicates sounds not tested

Subsequently, a number of relatively recent studies have also explored speech sound development in the Indian context. In Kannada, Deepa and Savithri (2010) explored the speech sound development in 240 children of age between 2-6 years and

found a definite pattern in the articulatory acquisition. By 2 years of age, acquisition of all vowels and diphthongs were completed based on 90% criteria and most of the consonants were acquired by 2.6 years except fricatives, affricates, laterals and clusters. Except /rʧ/, all other consonant clusters achieved 90% criteria by 6 years. Divyashree and Sreedevi (2018) studied the acquisition of 49 non-geminate clusters in Kannada and reported that 11 clusters were mastered by >3;6 to ≤4;0 years which were increased up to 41 clusters by >4;6 to ≤5;0 years and only three complex clusters persist to last age group (>5;6 to ≤ 6;0) and achieved mastery. Two element clusters were easier and earlier to acquire than three element clusters and medial clusters were acquired earlier over initial clusters. stop+/l/ clusters were earliest to develop while stop+/r/ clusters being the later ones to master.

In Telugu, Usha Rani and Sreedevi (2010) reported that all the vowels and consonants except aspirated stops and affricates were acquired by 3 years of age according to 90% criteria. Clusters were still emerging and did not reach 75% acquisition criteria by the age of 3 years. Speech sound development in Telugu appeared to be relatively earlier than other Indian languages, attributing to cultural differences. Subsequently, Sneha and Sreedevi (2012) found an earlier acquisition of medial clusters compared to initial clusters, achieving mastery between 4;0 and 4;6 years whereas initial clusters were mastered by 5;7-6;0 years of age in a study on non-geminate consonant cluster acquisition.

Perumal et al (2014,2019) investigated consonant acquisition in 2-4 years old Tamil children and showed that except for retroflex trill /r/ and laterals, all other consonants were acquired by 3 years of age. The latter sounds were acquired by 4;11 years.

Pooja and Sreedevi (2013) studied 180 typically developing Odia children aged between 2-5 years and observed that all vowels, diphthongs and several singleton sounds including aspirated ones, were acquired by 2;0-2;6 years according to 75% criteria. Additionally, it was found that 90% mastery of all consonants in Odia was achieved by 4;0-4;6 years of age. Notable point was unvoiced affricate /ʧ/ was achieved by 2.6 years of age indicating an earlier acquisition compared to established norms

Since the present study entails bilingual children who are native Malayalam speakers, it is necessary to endeavor the speech sound acquisition of Malayalam monolingual children to discern the influence of bilingualism on the age and sequence of acquisition. Numerous studies have investigated Malayalam speech sound acquisition in children across a broad age group (Divya & Sreedevi, 2010: Maya & Savithri, 1990; Neenu, Vipina, Vrinda & Sreedevi, 2011).

A summary of speech sound development in Malayalam according to different studies at AIISH is given in Table 2.3

Table 2.3

Speech sound development in Malayalam

Speech sounds	Maya & Savithri (1990) (>3;0 -≤7 years of age) *75%	Divya & Sreedevi (2010) (>2;0- ≤3;0 years of age) *75%	* 90%	Neenu et al (2011) (>3;0- ≤6;0 years of age) *100%
/m/	3-3.6	2-2.3	2-2.3	3-3.3
/n/	3-3.6	2-2.3	2-2.3	3-3.3
/ŋ/	3-3.6	2-2.3		3.4-3.6
/p/	3-3.6	2-2.3	2-2.3	3-3.3
/f/	3-3.6	-	2.6-2.9	3.4-3.6
/h/	3-3.6	-	-	-
/k/	3-3.6	2-2.3	2-2.3	3-3.3
/b/	3-3.6	2-2.3	2-2.3	3-3.3
/ɖ/	3-3.6	2-2.3	2.3-2.6	3.4-3.6
/g/	3-3.6	2.3-2.6	2.3-2.6	3.4-3.6
/r/	3.7-4	2.6-2.9	2.6-2.9	4.1-4.3
/s/	3.6-4	-	2.6-2.9	4.1-4.3
/ʃ/	5-5-.6	-	2.6-2.9	4.1-4.3
/ʧ/	3-3.6	2-2.3	2.3-2.6	4.1-4.3
/ʈ/	3-3.6	2-2.3	2.3-2.6	3.4-3.6
/ʋ/	3-3.6	2.3-2.6	2.6-2.9	3.4-3.6
/l/	3-3.6	-	-	3.4-3.6
/j/	3-3.6	2-2.3	2.3-2.6	3-3.3

Note: * Indicate acquisition criteria of sounds '- '*indicates* sounds not acquired at specific age levels. Blank space indicates sounds not tested

These studies indicate a discernible shift towards early chronological mastery of speech sounds in Malayalam. This change in children is attributed to differences in lifestyle and strong exposure to speech and language. Few subsequent studies explored the early phonetic repertoire of infants from 1 to 2 years of age.

Irfana and Sreedevi (2012) investigated early phonetic repertoire in 8 typically developing children in the age range of 12-18 months through naturalistic speech

samples and identified 23 singleton consonants in phonetic repertoire of the toddlers, dominated by stops with bilabials and dentals most frequent; however, older children showed an increased mastery of dental, retroflex and velar sounds. Alphonsa and Sreedevi (2012) extended the investigation to eight 18–24-month children and indicated that consonantal repertoire increased to 26 singleton consonants, primarily dominated by stops, nasals and glides. Age related increase of alveolar and palatal sounds was also observed.

Vowels were found to be early developing and infants had a repertoire of six vowels and two diphthongs (a, i, u, o, e, ə, au, ai) with predominant occurrence of low vowel [a] in 12-18 months, which was doubled to twelve by 24 months (Alphonsa & Sreedevi, 2012; Irfana & Sreedevi, 2012). The acquisition of vowels was found to be completed by 2.3 years of age except /u/ and /u:/ which were fully acquired by 2.6 years (Divya & Sreedevi, 2010) indicating an earlier development. Similarly, Maya and Savithri (1990) and Neenu et al (2011) found that all vowels were fully acquired by 3 years congruous with research in both Indian and International contexts.

Considering consonant clusters, both geminate and non-geminate clusters were present, with more diversity by 15-18 months (Irfana & Sreedevi, 2012)) and only medial geminate and medial non-geminate clusters were seen between 18-24 months, predominated by nasal geminates [mm] (Alphonsa & Sreedevi, 2012). Additionally, Divya and Sreedevi (2010) stated that clusters were emerging in 3-year-old children. This finding is supported by Asin et al. (2024) where they found that 20 out of the 30 clusters were acquired by the age of 3, considering 50% acquisition criteria. Three element clusters with /r/ and /l̪/ was challenging for 2-3 years old children and medial clusters were acquired earlier than initial clusters. Similarly, Neenu and Sreedevi (2011) indicated that initial clusters /kj/ and /kl/ achieved 75%

acquisition criteria by 4 years of age, however, majority of the medial clusters were acquired earlier, by 3.3-3.6 years of age and mastered by 4.0-4.3 years. Meanwhile, majority of initial clusters were mastered by 5-6 years (Vipina & Sreedevi, 2011; Vrinda & Sreedevi, 2011).

According to the review of literature, studies from various languages reveal a global trend in the speech sound development of monolingual children. Children acquire sounds in a predictable manner based on their motor complexity. Vowels and sounds like nasals, plosives and approximants are mastered earlier, typically by 2-3 years of age. In contrast, more complex sounds like fricatives, affricates, laterals and trills are developed later by 3-4 years of age and continue to be mastered until 5 years of age. Consonant clusters showed a prolonged developmental course, acquiring mastery by 5-6 years. Although this general pattern appears universal, variability exists in the exact timing and mastering, which can be attributed to linguistic and individual variations.

One of the crucial reasons for variability in speech sound development can be associated with bilingualism. There is a contemporary shift towards bilingualism which is driven by increased globalization, migration, cross-cultural communication etc. Bilingualism is widespread in India, due to its multilingual society and most Indians are exposed to English since a young age, suggesting a cross-linguistic influences on both speech sound and overall language development.

2.6. Bilingualism and language development in children

Bilinguals actively use at least two languages in daily life, but the experience of bilingualism is unique to everyone, which makes defining bilingualism a complex task. Thus, different authors suggest distinct definitions to bilingualism. A very simple definition of bilingualism is ‘knowing two languages” (Valdez & Figueora,

1994). Bloomfield (1933) stated that bilingualism is the “native-like control of two languages”, but few authors argue that the native like proficiency is rare (Cutler et al.,1992). Harding and Riley (2003) defined bilingualism as the knowledge and use of two languages and one’s ability to make an utterance in another language. One of the most acceptable definitions was given by Li (2008) i.e., “anyone who can communicate in more than one language, be it active (through speaking and writing) or passive (through listening and reading)”. Finally, bilingualism, is defined as “The regular use of one or more languages by a person or within a community” (American Psychological Association [APA], 2018). Usually, bilingualism is determined by the frequent use of two languages rather than proficiency and competence in both.

Bilingualism is generally classified based on the mastery in both languages (balanced vs dominant bilingualism) and the age of acquisition of both languages (simultaneous vs sequential bilingualism) and other factors (compound and coordinate bilingualism). Balanced bilinguals are those who have similar proficiency in both languages, while dominant bilinguals have higher proficiency in one language over the other (Dornic, 1980; Taeschner, 1983). It is suggested that dominant bilinguals perform better than balanced bilinguals (Rao, 1975). Compound and coordinate bilingualism is associated with language independency and interdependency (Maitreyee & Goswami, 2009). Compound bilinguals are those who have learnt both languages in the same environmental context or L2 through translation whereas coordinated bilinguals learn language in different context and are able to make them separate.

According to the age of acquisition, bilingualism is broadly divided into three types, Bilingual first language-acquisition (BFLA), simultaneous bilingualism and sequential bilingualism (Gildersleeve-Neumann &Wright, 2010). Bilingual first

language-acquisition is usually postulated to describe those children who are exposed to both languages since birth (deHouwer,2009; Meisel,1989). In BFLA, one language may be considered as language alpha and other one language beta. BFLA is generally used synonymously with simultaneous bilingualism, even though several authors define simultaneous bilingualism as exposure to second language (L2) after birth, during the process of learning first language, mostly synchronous with it i.e., approximately before 3 years of age. (Bleile, 2025; Gildersleeve-Neumann & Wright, 2010). Meanwhile, sequential bilingualism is the learning of L2 after a fundamental part of L1 is acquired. The arbitrary cut off age is often considered 3 years (Hammer et al., 2004; McLaughlin, 1978).

Early bilinguals may acquire language simultaneously or sequentially. According to DeHouwer (2009), early sequential bilinguals are those who acquire a second language while a partial acquisition of first language is already occurred, and late bilinguals are those who learn L2 at adolescence. Few restricted definitions of simultaneous bilingualism indicate they may learn both languages since birth or very soon after, usually before one year of age (Paradis et al., 2004) or by 18 months (Kim et al., 2018). Yet, most of the authors do not specify strict criteria for the cut-off age. Thus, simultaneous bilingualism is usually considered the concurrent learning of two languages beginning at the same time shortly after birth usually during infancy (Kohnert et al., 2020) or afore the age of 3 years (Bleile, 2025). In simultaneous bilingualism, each parent or care giver may use a separate language to talk or they may use both languages to converse with the child.

Rapid neuronal maturation occurs in the early years of life, postulating a time when sensitivity of the brain is at peak for sensory experiences, usually around 3 years. Thus, multiple language exposures during this period of time may be taking

larger advantage of neuroplasticity by delaying the closing of this sensitive period. As a result, even-though the brains of both simultaneous and sequential bilinguals undergo reorganization during development, the manifestation could be different for simultaneous bilinguals (Berken et al., 2017). Simultaneous bilingualism may facilitate overall brain development by enhancing a range of linguistic and cognitive processes.

Bilingual children experience language development through acquisition of two linguistic systems, which can influence various aspects of their cognitive and communication abilities. Several studies have explored language development in bilingual children. It is generally believed that simultaneous bilingual children may have comparable competence in both languages, similar to monolinguals. However, research arrived on contradictory evidences indicating accelerated and delayed language acquisition in bilinguals (Hoff et al., 2012: Hoff & Core, 2013; Van, Hong, 2025: Volterra & Taeschner, 1978)

Volterra and Taeschner (1978) conducted a longitudinal analysis to study gradual process by which a child becomes bilingual from early infancy considering three participants with simultaneous acquisition of both languages from 1.0 to 4.0 years, including one English-German child and two Italian-German children. They concluded that the children have one lexical system that includes words from both languages and true bilingualism is only achieved when the linguistic codes are independent and child does not rely on specific people or social categories to mediate their language use.

The acquisition of two languages by bilingual children is not at the same rate as monolingual children (Hoff et al., 2012). They compared language development of Spanish- English bilingual and monolingual children between the ages 1;10 and 2;6.

Monolingual children had more advanced language skills than the bilinguals, both in vocabulary and grammar in the single language comparison. However, total vocabulary was found to be comparable. All measures of vocabulary and grammar were related to the linguistic input of that language in case of bilinguals.

Similarly, Hoff and Core (2013) reviewed bilingual first language development under 5 years on simultaneous bilingual children residing in the US. Across studies, researchers found that the rate of language acquisition is lagging in bilingual children compared to monolinguals. They also considered input effects on bilingual language acquisition and it was found that a minimal threshold of at least 20% of input is needed for language to be acquired.

A systematic review was conducted by Van Hong (2025) and analyzed 12 studies to get insights on lexical and grammatical development of simultaneous and sequential bilinguals. Consistent results were present in terms of lexical knowledge and vocabulary development. Sequential bilingual children performed less accurately on vocabulary assessments in comparison to simultaneous bilinguals. Nevertheless, on single language comparisons, simultaneous bilinguals showed a lower performance than monolinguals. Furthermore, monolinguals were observed to be more advanced than both simultaneous and sequential bilinguals in terms of grammatical development and usage and comparable results were observed among both bilingual groups.

On the contrary, few studies support acceleration hypothesis in bilingual children. Campbell and Sais (1995) compared monolingual English and bilingual Italian-English children on a metalinguistic awareness task. Results showed a higher performance of bilingual children than their monolingual peers in both morpheme deletion and phonological sorting and concluded that second languages exposure at a

pre-literate stage leads to accelerated ability in manipulating sound structure of language enhancing reading skills.

Pearson et al (1993) compared simultaneous English-Spanish bilinguals and monolingual children of age 8-30 months on vocabulary development and they found no statistical basis to conclude bilingual children were slower than their monolingual peers in early vocabulary development. Both the groups had comparable scores on speech comprehension and production. They suggested that while bilinguals may appear 'delayed' in one language, their total and conceptual knowledge is equivalent to monolinguals.

In the Indian context, Sangeetha and Swapna (2011) compared the cognitive-linguistic abilities of simultaneous and sequential Kannada-English bilingual children in the age range of 7-8 years by assessing attention, memory and problem-solving and observed simultaneous children outperformed sequential bilinguals in all cognitive linguistic tasks, which could be attributed to the age of acquisition of second language and extent of bilingualism.

Harini and Shyamala (2008) compared code mixing and code-switching behaviors of Kannada- English simultaneous and sequential bilingual children of 4-8 years of age and indicated that code mixing and code-switching behaviors were prevalent in the sequential bilinguals compared to simultaneous bilinguals, which can be attributed to difference in the mastery of both languages. Insertion of English lexemes to Kannada was more frequent than Kannada lexemes into English which can be due to increased exposure and usage of English at school and peer-group.

More recently, Prakruthi and Shanbal (2022) analyzed the code mixing and code switching of 30 Kannada-English sequential bilinguals of age 8-10 years. Code switching was not observed in both of the age groups, indicating it may develop later

stage in their life. However, intra- sentential code switching was found in both age groups with a greater instance in the younger age group indicating inadequate language proficiency and the influence of English on Kannada was evident through borrowed words.

Aparna and Shanbal (2015) studied the effect of English in Malayalam speaking children by analyzing the code mixing and code-switching patterns in 60 Malayalam-English sequential bilingual children aged 6-8 years and a developmental trend was indicated from a high frequency of code mixing observed in 6-7 years old children compared to older group which can be due to the reduced proficiency in the languages. Code mixing was reduced as the age increased while code switching was found to be absent in both age groups.

Regardless of the contradicting evidence, it is generally accepted that bilingualism seldom delays the language acquisition of bilingual children. Bilinguals and monolinguals have comparable ability in understanding and using the languages. The influence of bilingualism on specific components of speech and language acquisition, especially bilingual speech sound development, is an emerging area of interest for several researchers.

2.8. Speech sound development in typically developing bilingual children

Bilingualism can be defined as the use of two languages for communication. In recent years, the number of individuals who are bilingual has shown significant growth globally. An increasing number of children are exposed to at least two languages from an early age. Thus, their pattern of speech sound acquisition is expected to differ from that of monolingual children. Speech sound development in bilingual children follows a complex trajectory influenced by simultaneous or sequential exposure to both linguistic systems. The process of speech sound

acquisition reflects the specific phonological characteristics of each language. Only a limited number of studies have examined the age of acquisition of bilingual speech sound development; instead, the majority have focused on the cross-linguistic influence between the languages.

A bilingual child may have a general advantage over the peer monolinguals in speech sound production, as the former is exposed to larger speech sound and syllable inventory across both languages. Several factors can be accounted for speech sound development of bilingual children. These include language-internal factors such as frequency which refers to low or high presence of a segment or phonological structures and complexity which is the typological markedness (Kehoe & Havy, 2019). The elevated frequency and complexity of linguistic properties such as codas and clusters in one language can foster superior accuracy in that specific area across both languages. Moreover, speech production abilities are often associated with lexical factors, such as vocabulary size and language specific vocabulary (Kehoe & Havy, 2019)

Language external factors such as quantity of language input, where faster phonological development is associated with dominant language (Mayr et al., 2015). Different outcomes are expected regarding the influence of other factors such as socio-economic status and gender on bilingual speech sound acquisition. Generally, children from lower socio-economic status perform poorly (Calvo & Bialystok, 2014) however, findings were equivocal considering phonological production (McLeod, 2009). With respect to age, girls are found making lesser errors than boys, Furthermore, phonetic and phonological maturation may also be a factor providing different developmental timelines for phonological structures. (Kehoe & Havy, 2019).

The measurement of speech sound accuracy in bilingual children should also incorporate these factors to accurately assess speech sound production, which is essential to mitigate the risk of misdiagnosis when evaluating bilingual population (Fabiano-Smith et al., 2021; Speights Atkins et al., 2017). For addressing this, speech language pathologists have been consistently using accuracy measures such as Percentage of Consonants Correct (PCC), Percentage of Vowels Correct (PVC), Speech intelligibility etc. to quantify the proportion of adult-like phonetic realizations in a child's speech sample (Marecka et al., 2020). Percentage of Consonants Correct is established as a positive indicator of phonological ability in bilingual children with a strong correlation to speech intelligibility (Fabiano-Smith & Hoffman, 2018). Majority of the studies have considered these speech sound accuracy measures to explore the influence of two languages on bilingual speech sound development (Fabiano-Smith & Goldstein, 2010b; Meziane & MacLeod, 2021) and arrived at theoretical explanations and models depicting the effect of bilingualism on speech sound accuracy and speech sound development.

Models which consider age of acquisition, language proficiency, length and type of L2 exposure, development and capacity of perceptual and cognitive systems, individual variations and other areas such as rhythm and intonation are challenging to develop but will be helpful for SLPs while assessing speech of bilingual children to understand the impact of L2 on speech sound development. (Hambly et al., 2013)

Three models are postulated for understanding bilingual language and phonological representation. One of the earliest and currently outdated 'The Unified System Model' conveyed that an integrated system exists in bilinguals which gets separated over time. In other words, there is a single storage system for both languages and as usage increases, the networks and connections between elements of

the same language get stronger (Vogel, 1975; Volterra & Taeschner, 1978). The children are able to differentiate between two lexicons, however, they apply the same syntactic rules to both languages and even though there are different linguistic codes that differentiate lexicons and syntax, each language is exclusively associated with the person who is using it. The tendency to categorize people in terms of their languages decreases by the end of this stage, and children become true bilinguals.

Contrarily, 'Dual System Model' (Genesee, 1989; Paradis, 2001) suggests an existence of separate system for each language, with different rules, phonemes words etc. Studies on speech perception showed that bilingual infants as young as 4 months could discriminate between rhythmic patterns of their two native languages (Bosch & Sebastián-Gallés, 2001)

At present, the generally accepted and recognized model is 'Interactional Dual System Model-IDSM' (Paradis, 2001). According to this hypothesis, simultaneous bilingual children acquire distinct phonological system for each language from birth. Nevertheless, these two systems influence one another, demonstrating a systematic interdependence across systems. Paradis (2001) compared 17 French-English bilingual children (age range 23-35 months) with 18 monolingual French (age range 28-36 months) and 18 monolingual English children (age range 22-34 months) on their repetition of nonsense words to determine whether two phonological systems exist for 2-year-old bilingual children and indicated the influence of French stress patterns on English. She confirmed the IDSM by stating that two separate but non-autonomous systems exist in 2-year-old bilingual children with minimal overlap. Currently most researchers agree that two interrelated, non-independent systems exist in bilingual children (Gildersleeve-Neumann & Goldstein, 2015; Hambly et al., 2013).

Paradis and Genesee (1996) put forward three hypotheses on bilingual language acquisition, i.e., Transfer, Acceleration and Delay. Speech sounds including consonants and vowels that are language specific to one will transfer to production of other languages which is known as segmental transfer. (Fabiano-Smith & Goldstein, 2010). The second hypothesis states that grammar, and in a broad level sense, phonology of bilingual children will emerge at a fast rate compared to monolingual children on the premise of interaction between the two languages which boosts developmental processes. Exposure to Polish complex word-initial clusters accelerated the development of less complex clusters of English in simultaneous Polish-English bilingual children in the age range of 7;0-8;11 years. (Tamburelli et al., 2015). Aspect of phonological development is slower in the bilingual children relative to monolingual children according to the third hypothesis, delay. The premise of this hypothesis was based on the interaction of both languages which may interfere with developmental process, leading to poor linguistic skills.

According to the Unified competition model by MacWhinney (2005), children are sensitive to phonological properties across languages. He also postulated that input with frequent and reliable information has strongest cue strength which facilitates rapid and easy acquisition. This act as a framework for predicting the phonological skill development in bilingual children. Goldstein and Bunta (2012) hypothesized the idea of positive and negative transfer on the basis of this model. They put forward that positive transfer happens when there are greater cue strength and reliability between two languages which result in faster phonological development in bilingual children than their monolingual peers. If phonological development of bilingual children is at a slower rate than in monolingual peers, it may

indicate negative transfer. This happens when unique properties are present across languages.

Gildersleeve-Neumann et al. (2008) compared inventory and accuracy of production of English speech sounds in thirty-three 3–4-year-old monolingual English children with Spanish-English bilingual children through a longitudinal study. The participants were grouped into three, English only, Predominantly English and English-Spanish balanced bilingual children. Children were able to produce full range of English vowel height and front/back dimensions. All groups of children produced stops, nasals, glides, fricatives and liquids by the age of 3 years. Affricates were found to be difficult for bilingual children to master compared to monolingual children. Furthermore, monolingual children produced consonant clusters on all word positions, mastering it by 4 years old, while bilingual children could not meet the criteria of mastery of consonant clusters. It was found that bilingual children with more exposure to Spanish made frequent errors compared to monolinguals. Even though phonetic inventories were similar, cross-linguistic effects were evident including frequent gliding of /l/ and /ɹ/ by the English-Spanish balanced bilinguals, suggesting influence of Spanish in the allophones of English. Both bilingual groups showed higher error patterns in comparison with monolingual children. They reflected that higher error rates are likely typical for bilingual children.

Fabiano-Smith and Goldstein (2010) investigated phonological acquisition in 24 Spanish-English bilingual children aged between 3-4 years, which included three groups; bilinguals (with at least 20% of input and output of both languages) and monolinguals of both languages. Results indicated that bilingual children could not produce few sounds such as flaps in Spanish and consonant accuracy in Spanish was also lower for bilingual children than their Spanish monolingual peers. On the other

hand, bilinguals showed a higher accuracy in shared than in unshared sounds. They concluded that bilingual children have a separation between two phonological systems and they showed somewhat slower but within the normal limit rate of acquisition in phonological accuracy as compared to their monolingual peers.

Lee (2020) investigated similarities in the consonants and vowel productions of Korean-English simultaneous bilingual children with groups of Korean monolingual and English monolingual peers. They also examined the influence of phoneme inventory size and complexity of consonant and vowel categories. The study considered 24 typically developing children in the age range of 3;1 - 3;6 years in three groups and findings showed that children of all groups demonstrated typical speech sound inventory according to the age and all vowels were acquired by most of the children. Overall accuracy for English speech sounds was similar for all groups and simultaneous bilingual children produced phonemes of the dominant language (English) more accurately than phonemes of less dominant language (Korean) even across the same sound categories (stops, affricates, etc.) which can be attributed to larger phoneme size and complexity of Korean. Thus, they concluded that phoneme production accuracy of Korean-English simultaneous bilingual children is affected by their language dominance.

Debski et al (2022) studied 57 typically developing bilingual Polish-Ukrainian preschool children of age between 4.0-6.0 years along with age matched monolingual children of both languages to identify the syntagmatic and paradigmatic speech sound errors as well as impact of participant variables on their phonological performance indicators. The results illustrated a complex picture of bilingual phonological development. The bilingual children showed quantitatively proportional phonological skills in Polish (additional language) with their monolingual peers except for vowels

but phonological skills in Ukrainian was weaker than those of monolinguals. Moreover, the otherwise typical patterns contained numerous uncommon errors due to bi-directional cross-linguistic transfer which authors interpreted due to the typological and geographical closeness of languages. While these studies reflected the recurrence negative transfer, additional evidences propose cross-linguistic interaction with an equivocal performance or positive transfer between both languages.

Lim and Chieng (2022) investigated English and Malay speech acquisition in 40 Indian-Tamil children in Malaysia. The participants were early simultaneous multilinguals aged between 2;06 and 4;05 years with limited exposure to Tamil despite their heritage. The findings showed that their phonological milestones were comparable to those of bilingual children from other ethnicities. Specifically, vowels were mastered by the age of 2;11, and most consonants were mastered by 4;06 years. Based on these results, Lim and Chieng concluded that bilingualism does not place a burden on or delay the acquisition of a second language phonology for children raised in the multilingual context of Asia.

The area of speech sound development or phonological development in bilingual children remains underexplored. As indicated by some evidence, monolingual and bilingual children show different patterns of production (Lin & Johnson, 2010). They studied phonological patterns in Mandarin-English sequential bilingual children in the age range of 4-5 years and compared them to a monolingual peer group using single-word articulation tests in both languages. The results indicated that the phonological patterns in bilingual and monolingual children appeared to be similar and there were no significant differences in the phoneme accuracy in bilinguals as compared to their monolingual peers.

Anderson (2004) conducted a longitudinal study to investigate the phonological development of preschoolers who are sequential bilinguals, learning English as a second language through immersion. Five children in the age range of 3;9-4;9 years from various linguistic backgrounds, i.e., three native Korean speakers and one Russian and French speaker each, participated in the study. All children produced most of the phonemes of their native language and English. The results indicated that children use their knowledge of L1 to promote phoneme acquisition in the second language, additionally, they maintain a distinct phonological system. A transfer of articulatory skills from L1 to L2 was observed. Children's speech sound inventories for both L1 and L2 included shared sounds, which were produced with higher accuracy in L2.

Despite a separation of phonological structures being maintained by bilingual children, a low level of interaction between the two languages seems to exist (Fabiano-Smith & Barlow, 2010). They considered 24 Spanish-English bilingual children aged between 3-4 years in three groups; bilinguals and monolinguals of both languages. The results reflected that the complexity of bilinguals' phonetic inventory was comparable in both the languages. Bilingual's acquisition of two inventories was completed within the same amount of time as monolingual's acquisition of one inventory with the same complexity and inventories across the languages were found to be similar, not identical. Evidence of bidirectional transfer was observed between both languages, supporting findings of Paradis and Genesee (1996).

Meziane and MacLeod, (2021) documented phonological transfer across Arabic and French in nine 3- year- old bilingual children. They participated in a picture naming task and consonant accuracy; inventory of acquired consonants and type of errors were assessed. The results were consistent with previous studies, i.e., an

existence of similar, but not identical, inventories across the languages. The two phonological systems interacted with each other. The production of shared consonants was more accurate which indicated a positive interaction compared to less accuracy of unshared consonants indicating a negative interaction.

Consonant and cluster accuracy improved significantly in both languages in Spanish-English bilingual preschoolers over the course of a year (Montanari et al., 2018). The study was conducted on 35 children of ages 3.7 years to 4.7 years. They found that the growth in English was more prominent. Most common English singleton consonant errors were consonant deletion, stopping and devoicing at age 3;7, whereas reduction and simplification patterns were predominantly observed in cluster errors. Skills in other language domains and speech production abilities develop together. They also confirmed the positive and negative transfer by stating that the errors predominantly affected language-specific sounds and accuracy rates of unshared sounds and clusters were significantly lower than those of shared ones.

Similar findings were derived from other studies with bilingual children. Bilinguals seem to acquire two distinct phonological systems that differ from monolingual children, implying that learning more than one language leads to an interaction between the two phonologies (Fuenzalida-Muñoz, 2025). 20 typically developing children of age between 2;9 - 5;6 years (10 monolinguals of both languages and 10 Spanish-Valencian bilinguals) were included in their study. Findings reveal that most phones were produced by all children across groups except for the shared phones and few language specific phonemes. Performance of bilinguals slightly differed according to the language. Age of production of phones also differed slightly with /ð/ being the only phone whose age of production was the same across the three groups. Bilinguals showed overall an earlier acquisition of phonemes

depending on the sound and interaction between languages. They concluded that a complex correlation exists between the language of input and monolingualism or bilingualism.

Gildersleeve-Neumann and Wright (2010) explored the influence of phonetic and phonological properties of Russian on single-word productions of English on 14 Russian-English (RE) bilingual (simultaneous and sequential) and 28 English (E) monolingual children of 3-5 years of age and found out all RE and E children produced all monophthong vowels of English, regardless of their age. Also, early developing English consonants were produced by all RE children along with a similar frequency in production of later developing sounds by all RE and E children of ≥5 years of age. Rate of errors was lower in older age groups. They concluded that bilingual children produced phones in English which had influence of Russian, for example, palatalized consonants and trills.

Bilingual speech sound development studies in the Indian context are almost non-existent, let alone in simultaneous bilinguals. Bailoor and Krishnan (2014) studied development of phonological process and compared it to that of monolinguals in 3–4-year-old Kannada-English bilingual children. The results showed the occurrence of the phonological processes were lesser for bilinguals than monolinguals indicating a better performance by bilinguals in phonological tasks.

These studies present with recurrent evidence on the cross-linguistic influences between languages, which have a solid impact on the development of speech sound acquisition. Even though the phonetic characteristics among both languages of a simultaneous bilingual child vary, an interaction between the languages exist. However, only few studies have explored the speech sound development of bilingual children in the Indian context. As the present study focuses

on speech sound development of Malayalam-English simultaneous bilinguals, it is crucial to understand the phonology of both languages.

2.3. Malayalam and English Phonology

India is a multicultural and multilingual country. Major language families in India include Indo-Aryan (a sub-family of Indo-European) and Dravidian (Sengupta & Saha, 2016). Malayalam is a Dravidian language spoken by more than 33 million people in India, native to the southern state of Kerala and the union territories of Lakshadweep and Mahe. Malayalam is one of the 22 scheduled languages as well as one of the 11 classical languages in India.

Malayalam has 11 vowel phonemes (monophthongs) and 5 diphthongs in their phonology. The monophthongs include high-front sounds /i/ and /i:/; mid-front sounds /e/ and /e:/; High-back sounds /u/ and /u:/; mid-back sounds /o/ and /o:/; low-central sounds /a/ and /a:/ and finally high- back vowel /U/ (Syamala Kumari, 1972). Besides, mid-central vowel /ə/ is also considered a vowel in Malayalam (Jiang, 2010, Kumari, 1997) and diphthongs include /ai/, /au/, /ei/, /ia/ and /ua/. In addition to these vowels, there is a low front vowel, /æ/ which occurs in the loan words from English. The number of consonant phonemes in Malayalam is debatable, ranging from 28 (Syamala Kumari, 1972), 35 (Krishnamurti, 2003) to 52 (Jiang, 2010). Considering Krishnamurti's (2003) study, stops [p, t̪, t, ʈ, tʃ, k, b, d̪, ɖ,dʒ , g, bʱ, d̪ʱ, ɖʱ, dʒʱ, and gʱ], the nasals [m, n̪, n, ɳ, ɲ, ŋ], the liquids [r, ɾ, ɻ, l, ɭ], the glides [ʋ, j] and the fricatives [s, ʃ, ʂ, h] are present in Malayalam. According to Shyamala Kumari (1972) consonants of Malayalam include 11 stops, 6 nasals, 4 fricatives, 3 laterals, one flap, one trill and 2 frictionless continuants. Stops are grouped into voiced and voiceless counterparts except for the alveolar stop. A labiodental voiceless fricative /f/ is present in addition to the 4 fricatives, which occurs in certain loanwords similar to

vowel /æ/. Fricatives are voiceless except /h/. None of the nasals except /m/ occur at all word positions. Lateral /l/, trill /R/ and continuant /j/ occur at all positions while flap /r/ occurs at non-final positions. Malayalam maintains a 4-way contrast in its formal and lexicalized register (Jiang, 2010; Mohanan & Mohanan, 1984), However, Geethakumary (1997) suggests that voiced aspirates are exclusively found in loan English words and in colloquial Malayalam, voiced aspirates are frequently deaspirated, thus maintaining a 3-way contrast. Consonants and vowels in Malayalam are showed in Table 2.4 and Table 2.5 respectively.

Table 2.4

Consonants in Malayalam

Sound classes	Bilabials	Labiodental	Dental	Alveolar	Retroflex / Post-alveolar	Palatal	Velar	Glottal
Plosives	/p/, /b/		/t̪/, /d̪/	/t/	/ʈ/, /ɖ/		/k/, /g/	
Nasals	/m/		/n̪/	/n/	/ɳ/	/ɲ/	/ŋ/	
Fricatives		/f/*		/s/	/ʂ/	/ʃ/		/h/
Affricates						/tʃ/, /dʒ/		
Liquids Laterals				/l/	/ɭ/, /ɻ/			
Trill					/r/			
Flap				/ɾ/				
Central approx/ glides/continuants		/ʋ/				/j/		

Note: Data adapted from *Malayalam: A grammatical sketch and a text* by Jiang (2010) and *Malayalam phonetic reader. (vol 2)* by Syamala Kumari (1972).

Table 2.5

Vowels in Malayalam

Vowels	High	Mid	Low
Front	i, i:	e, e:	
Central		ə	a, a:
Back	u, u:	o, o:	

Note: Adapted from *Malayalam: A grammatical sketch and a text* by Jiang (2010) Table No. 5

English is a global West Germanic language in the Indo-European language family. It is widely accepted as the lingua franca. It is the dominant language of United States, United Kingdom, Canada, Ireland, Australia and New Zealand, and it is also considered as one of the official languages in other countries such as India and the Philippines. The phonology of English with respect to its pronunciation is different across the globe, while British Received Pronunciation (RP) is considered the standard. American English has at least 4 fewer vowels than British English for example, /ɒ/, the vowel in words such as hot in British English (Deterding, 2004). English has 44 speech sounds categorized as vowels and consonants. British English consists of a total of 20 vowels, including 12 monophthongs [i, e, ɪ, æ, ʌ, ɒ, ʊ, iː, ɑː, ɔː, uː, ɜ, ə] and 8 diphthongs [eI, aI, ɔI, əʊ, aʊ, Iə, eə, ʊə]. The 24 consonant sounds in English are classified by their manner of articulation. These are six plosives [p, b, t, d, k,,g]; 9 fricatives [f, v, θ, ð, ʒ, s, z, ʃ, h]; 2 affricates [tʃ, dʒ]; 3 nasals [m n ŋ]; one lateral-approximant /l/ and 3 approximants [w, j, r/ɹ] (Deterding, 2005). Table 2.6 and Table 2.7 show the consonants and vowels respectively of British English.

Table 2.6

Consonants in British English

Sound classes	Bilabials	Labiodental	Dental	Alveolar	Retroflex / Post-alveolar	Palatal	Velar/Labiovelar	Glottal
Plosives	/p/, /b/			/t/, /d/			/k/, /g/	
Nasals	/m/		/n/				/ŋ/	
Fricatives		/f/, /v/	/θ/, /ð/	/s/, /z/		/ʃ/		/h/
Affricates						/tʃ/, /dʒ/		
Liquids								
Laterals				/l/				
Rhotics						/r/		
Central approx/ glides/continuants						/j/	/w/	

Note: Data adapted from *How many consonant sounds are there in English?* by Deterding (2005)

Table 2.7

Vowels in British English

Vowels	High (close)	Mid	Low (open)
Front	ɪ, i:	e, e:	æ
Central		ə,ɜ	ʌ, a:
Back	ʊ, u:	ɔ, o:	ɒ

Note: Data adapted from *How many vowels sounds are there in English?* by Deterding (2004)

The phonological systems of Malayalam and English exhibit significant differences that are crucial to the understanding of speech sound acquisition in bilingual children. Unlike English, which lacks retroflex sounds and has only a two-way voicing contrast for its stops, Malayalam possesses a much richer consonant inventory, including distinct retroflex sounds and a four-way contrast that includes both voiced and voiceless aspirated and unaspirated stops considering its formal and lexical register (Mohanan & Mohanan, 1984). English has 9 fricatives all of which are not present in traditional Malayalam (Mandal et al., 2020). These are labiodental fricatives /f/ and /v/; dental fricatives /θ/ and /ð/ and voiced alveolar fricative /z/. Furthermore, Malayalam's vowel system relies on a phonemic distinction between short and long vowels, a feature less consistent in English. Aspiration in Malayalam is a phonemic feature to distinguish meaning, particularly from Sanskrit loanwords, whereas in English, voiceless plosives are usually aspirated at the start of stressed syllables. Considering rhoticity, Malayalam 'r' sound includes flap /r/ and trill /r/ which are not identical to English /r/. Similarly, Malayalam possesses more nasal

sounds, with 5 places of articulation, whereas English has only three. These distinctions create specific patterns of cross-linguistic influence that are critical to consider when analyzing the phonological development of bilingual children. Table 2.8 shows the shared and unshared sounds between Malayalam and English

Table 2.8

Shared and Unshared Sounds in Malayalam and English

Sound classes	Shared sounds	Unshared sounds specific to Malayalam	Unshared sounds specific to British English
Vowels	/a/, /i/, /u/, /e/, /o/, /iː/, /ɑː/, /oː/, /uː/, /ə/	/U/	/ɪ/, /æ/*, /ʌ/, /ɒ/, /ɜ/, /ɔː/
Diphthongs	/ai/, /au/		/eI/, /aI/, /ɔI/, /əʊ/, /aʊ/, /Iə/, /eə/, /ʊə/
Plosives/Stops	/p/, /b/, /k/, /g/	/ʈ/, /ɖ/, /ṭ/, /ḍ/	/t/, /d/
Nasals	/m/, /n/, /ŋ/	/ɳ/, /ɳ̍/, /ɲ/	
Fricatives	/s/, /ʃ/, /h/	/ʂ/	/f/*, /v/, /θ/, /ð/, /ʒ/,
Affricates	/tʃ/, / dʒ/		
Liquids			
Laterals	/l/	/ɭ/ or /l̩/, /ɻ/ or /l̠/	
Trills		/r/	
Flaps		/ɾ/	
Rhotic			/r/
Central approx/ glides/continuants	/j/, /w/		/v/

Note: * shared consonants of English loan words in Malayalam

To summarize, the literature review shows several studies indicating bilingual children develop speech sounds and show phonological abilities comparable to their monolingual peers. However, significant differences emerge at the level of specific

phonological structures, reflecting cross linguistic interaction between the two languages. Evidence suggests that bilingual children maintain separate yet interacting phonological systems, wherein both transfer and interaction effects shape speech production patterns. Furthermore, bilingual speech sound development is influenced by a combination of universal developmental processes and language specific factors, including the structural properties of the languages involved. Additionally, external variables such as language exposure, input quality and lexical development contribute to variability in outcomes. Although age of acquisition has been identified as an important factor in broader language development, its specific role in phonological acquisition remains relatively underexplored. In conclusion, these findings highlight that bilingual speech sound development is systematic, dynamic and shaped by multiple factors, rather than representing a deviation from monolingual patterns.

Chapter III

METHOD

The main objective of the study was to investigate the speech sound development and accuracy in Malayalam (L1)-English (L2) simultaneous bilingual children in the age range of 4-5 years.

3.1 Research Design

The study was normative research with age as the between-subject factor and language as the within-subject factor.

3.1 Participants

16 typically developing simultaneous bilingual Malayalam-English speaking children in the age range of 4-5 years were considered for the study. The participants were divided into two subgroups with an age interval of six months (>4;0 to ≤ 4;6 years [Group 1] and >4;6 to ≤ 5;0 years [Group 2]). Although an equal sample size of 8 participants per subgroup was initially planned, the final sample size varied due to logistic constraints. Consequently, the younger subgroup comprised 6 children and the older subgroup comprised 10 children. Participants were recruited through English-medium kindergarten schools, local preschools, and parent networks using convenient purposive sampling. The participants were identified from different localities of Kerala as well as from Mysore. The participants from Mysore had both parents native to Kerala and were ensured equal exposure and use of Malayalam and English. The inclusion and exclusion criteria were as follows:

Inclusion Criteria

Participants who were

1. In the age range of 4-5 years.
2. Native Malayalam speakers with exposure to both Malayalam and English.

3. Simultaneous bilinguals with exposure to English (L2) before the age of 3 years.
4. Bilingual children with equal opportunity to use both L1 and L2 which was ascertained using Questionnaire for parents (Shanbal & Prema, 2007)
5. Both the Parents or caregivers were literate and functionally proficient in both Malayalam and English which was ascertained using Language proficiency questionnaire (Maitreyee & Goswami,2009) with minimum rating of 3 (Good) in all items.
6. Having age-appropriate language age in both languages; assessed using Assessment Checklist for Speech Language Skills (Swapna et al., 2010).

Exclusion Criteria

Children with

1. History of structural, behavioral, cognitive, sensory, neurological problems or any syndromic disorders. WHO Ten-Question Disability Screening Checklist (Singhi et al., 2007) was used to screen the participants
2. Limited exposure to one or/and both languages
3. Dominant exposure to multiple languages
4. Sequential bilinguals with exposure of L2 after 3 years of age
5. One of the parent is Non-native Malayalam speaker

Table 3.1 shows the demographic details of the participants. The onset of exposure to Malayalam is since birth for all participants.

Table 3.1

Demographic Details of Participants

Participants	Gender	Age	Age of onset of exposure to English	Child's strongest language
P1	Male	4;0 years	1.5 years	Speaks both equally well
P2	Female	4;0 years	2 years	Predominantly Malayalam
P3	Female	4;4 years	2 years	Predominantly Malayalam
P4	Male	4;5 years	2 years	Predominantly Malayalam
P5	Female	4;5 years	1.10 years	Predominantly Malayalam
P6	Female	4;6 years	2 years	Predominantly Malayalam
P7	Female	4;7 years	2.5 years	Predominantly Malayalam
P8	Female	4;9 years	2.5 years	Predominantly Malayalam
P9	Male	4;10 years	2.5 years	Predominantly Malayalam
P10	Female	4;10 years	2.5 years	Predominantly Malayalam
P11	Female	4;10 years	1.8 years	Speaks both equally well
P12	Male	4;10 years	1.9 years	Predominantly Malayalam
P13	Female	5;0 years	1.5 years	Speaks both equally well
P14	Male	5;0 years	2 years	Speaks both equally well
P15	Female	5;0 years	2 years	Speaks both equally well
P16	Male	5;0 years	2 years	Predominantly Malayalam

3.3 Test Materials

The following test materials were used for all participants during data collection in both languages.

Articulation Tests

a) Malayalam Articulation Test-Revised (Neenu et al., 2011[1]) - Malayalam

[1] MAT-R was developed based on the individual dissertation works of Neenu, Vipina and Vrinda in 2011. Therefore, for the purpose of the present study, the test is collectively cited as mentioned as Neenu et al (2011) hereafter.

b) Goldman-Fristoe Test of Articulation - 3rd edition (Goldman & Fristoe, 2015) - English

Stimulus words list from MAT-R (Neenu et al., 2011) and GFTA-3 (Goldman & Fristoe, 2015) were used to assess Consonant/Vowel accuracy (SODA analysis) and Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC).

A total of 10 vowels (/a/, /a:/, /i/, /i:/, /u/, /u:/, /e/, /e:/, /o/, /o:/) were tested in Malayalam in the initial position and nine vowels (/o:/, /ɪ/, /ʌ/, /æ/, /e/, /ə/, /ɑ/, /ɛ/, /a:/) and three diphthongs (/aʊ/, /ɔɪ/, /aɪ/) were tested in English. All the vowels were tested in medial position in English. Additionally, /æ/ was tested in initial position and /i/, /u/, /u:/, /o/ in final position. Diphthongs were tested in medial position except /ɔɪ/ which was tested in final position

In Malayalam, 35 consonants were tested in which 17 in initial and medial positions, two in medial and final positions, three in initial, medial, final positions, five in initial position only and eight in medial position only. In English, 23 consonants were tested: five in initial and medial positions, one in medial and final positions, two in initial and final positions, 13 in initial, medial, final positions and two in initial only position.

A total of 28 clusters were tested in Malayalam: 12 in initial position, 13 in medial position and two in initial and medial positions. In English, 16 clusters were tested: 14 in initial position, one in final position and one in initial and medial positions.

Stimulus for Story Narration

A sequence of pictures in a printed format of the familiar story ‘The Thirsty Crow’ was used as a stimulus to obtain narration samples from the participants. This

sample was used to assess Percentage of Consonants Correct-Revised (PCC-R) and Percentage of speech intelligibility.

3.4 Instrumentation

The audio-video samples required for data collection were recorded through Samsung Galaxy A56 mobile phone. A mobile application downloaded from play store called 'Voice Recorder' (Version 3.39) with sampling rate 44 kHz and recording format PCM (wav) was used to record the participant's story narration and articulation test samples. These samples were further analyzed for obtaining the articulation outcome measures.

3.5 Procedure

Each participant was tested individually in a noise free room and the response obtained was audio-recorded. One of the participants (P11) was tested through online mode platform using Google Meet with bandwidth-300kbps to 4mbps (ISHA, 2019) and was audio-recorded. The story narration task was conducted first with the pictures in printed format which were sequentially arranged and presented to the participants one after the other. The participants were asked to narrate the story consecutively in both languages with a 5 minutes' interval. For some participants, the researcher narrated the story and instructed the participants to repeat it. Prompts were provided to elicit the responses. Following the story narration, articulation tests were administered in both Malayalam and English using the single-word elicitation task of MAT-R and GFTA-3 respectively. The response elicitation mode was through repetition.

3.6 Articulation Outcome Measures

The following four articulation outcome measures were extracted and analyzed from the data recorded from all 16 participants.

1. Consonant/ Vowel (CV) accuracy (SODA analysis)
2. Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC)
3. Percentage of consonants correct - Revised (PCC-R)
4. Percentage of Speech intelligibility

1. Consonant/ Vowel accuracy (SODA analysis)

The single word responses obtained from MAT-R (Neenu et al., 2011) and GFTA-3 (Goldman & Fristoe, 2015) were transcribed using broad phonetic transcription (International Phonetic Association [IPA], 2020). For GFTA-3, variations in IPA according to Indian-English pronunciations were incorporated. Substitution, omission, distortion, and addition errors if any were extracted from the recorded sample and Consonant/Vowel accuracy were assessed. The maximum score was 100 in MAT-R and 60 in GFTA-3. Hence, the scores of GFTA-3 were normalized to 100 to ensure uniformity in statistical comparison. A score of 1 was assigned for the correct production of the target phoneme. A score of 0.75 was assigned for distortion errors, 0.5 for substitution and 0 for omission errors. For clusters also, correct responses were scored 1. Coalescence (Eg:/spu:n/ to /fu:n/) cluster simplification (Eg:/spu:n/ to /pu:n/), metathesis (Eg: /biskaʈ:/ to /biksaʈ:/ and epenthesis (Eg: /st̪ʰalam/ to / sə-t̪ʰalam/) were assigned a score of 0.5. A score of 0.75 was assigned when the number of elements in the cluster is preserved and one or more of the consonants are substituted (Eg: /st̪ʰalam/ to /skalam/).

2. Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC)

All the words from the single-word elicitation task of MAT-R (Neenu et al., 2011) and GFTA-3 (Goldman & Fristoe, 2015) were analyzed to obtain WWA and

PWC. For WWA, if all the phonemes in the stimulus word are correct, a score of one was assigned. PWC was calculated using the following formula:

Proportion of Whole-Word Correctness (PWC) = Number of correct words/ (Number of correct words + words containing speech sound errors)

3. Percentage of consonants correct - Revised (PCC-R)

The recorded sample of storytelling was verbatim transcribed using broad phonetic transcription (International Phonetic Association [IPA], 2020) for each participant by the researcher in both languages. The number of correct consonants in the sample were identified to calculate the percentage of consonants correct using the following formula:

Percentage of Consonants Correct-Revised = Number of correct consonants / (number of correct consonants + number of incorrect consonants excluding distortions) x 100

4. Percentage of Speech intelligibility

The participants were asked to narrate the story of 'The Thirsty crow' which was presented in printed format and recorded in both languages. From the verbatim transcribed sample of each participant, the words that are intelligible were identified and calculated the percentage of speech intelligibility using the following formula:

Percentage of Speech intelligibility = (Number of intelligible words / total number of words uttered) x 100.

3.7 Assessment of Inter-Judge and Intra-Judge Reliability

Inter-judge and intra-judge reliability were carried out on the recorded data. For inter-judge reliability, three native Malayalam-English bilingual Speech-Language pathologists including the researcher transcribed 10% of the samples of articulation tests and story narration samples of both languages. For intra-judge

reliability also, 10% samples were reanalyzed by the researcher within a span of one week. No statistical tests were employed due to the smaller sample size of the data.

3.8 Statistical Analysis

SPSS version 26 was utilized for statistical analysis. Initially, the data was subjected to normality test using Shapiro-Wilk's test. Descriptive statistics were carried out to determine mean, median and standard deviation within and across groups for each articulation outcome measure. The Wilcoxon signed rank test was employed to determine the significant difference in the four outcome measures between L1 and L2 within age groups. Mann-Whitney U test was employed to determine the significant difference in the measures between the two age groups for both L1 and L2.

Chapter IV

RESULTS

The current study investigated the speech sound development and phoneme accuracy in L1 (Malayalam) and L2 (English) of Malayalam-English simultaneous bilingual children in the age range of 4-5 years.

The participants were divided into two subgroups, with an age interval of six months (>4;0 to ≤ 4;6 years [Group 1] and >4;6 to ≤ 5;0 years [Group 2]) with 6 participants in the first subgroup and 10 participants in the second subgroup, i.e., a total of 16 participants were included in the study. The speech samples of the participants were collected using articulation tests and story narration in both languages. Stimulus words list from MAT-R (Neenu et al., 2011) and GFTA-3 (Goldman & Fristoe, 2015) were used to assess the outcome measures 1) Consonant/Vowel accuracy and 2) Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC). A familiar story 'The Thirsty Crow' was used obtain the story narration samples of the participants to assess another two outcome measures, 3) Percentage of consonants correct-Revised (PCC-R) and 4) Percentage of speech intelligibility. The results of the study are discussed under the following headings:

4.1 Speech sound development pattern in Malayalam and English

4.2 Speech sound accuracy in Malayalam and English

4.3 Comparison of speech sound accuracy in Malayalam and English within age groups

4.4 Comparison of speech sound accuracy across age group for Malayalam and English

4.1 Speech sound development patterns in Malayalam and English

Phoneme-wise analysis was carried out to examine speech sound development pattern in Malayalam (L1) and English (L2) among typically developing simultaneous bilingual children across both age groups. The number of children who correctly produced each phoneme was identified in both languages and the two age groups.

4.1.1 Development of vowels and diphthongs

The results of the present study revealed that all 16 children correctly produced all 10 vowels tested in Malayalam by >4;0 to ≤ 4;6 years of age. In English, it was found that all vowels and diphthongs tested were correctly produced by all the participants by >4;0 to ≤ 4;6 years of age.

4.1.2 Development of singleton consonants

The present study considered 35 consonants in Malayalam and 23 consonants in English. The results indicated that the number of children who correctly produced consonants increased from group 1 to group 2 for both languages. According to SODA analysis, it was found that substitution was the most prominent error in both languages followed by omissions and distortions. In English, the number of children who correctly produced some phonemes varied across different words. In such cases, words produced by higher number of children were considered. For instance, 4/6 children correctly produced the consonant /h/ in initial position in the word /haʊs/ whereas 5/6 correctly produced the same phoneme in initial position in other word /hæmər/. Hence the highest production five is considered. In English, dialectal variations in the production of the dental fricatives /θ/, /ð/ were accepted as dental stops /t̪/, /d̪/ respectively as the former consonants are not produced in Indian context colloquially. Similarly, a post alveolar production of the sound /t/ was accepted. The number of children with correct productions for singleton consonants across the two

age groups in both Malayalam and English are presented in Table 4.1 and Table 4.2 respectively.

Table 4.1

Shows the number of children with correct production of Malayalam consonants

Sl. No	Phonemes	Word positions	Age groups	
			>4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
1	/k/	Initial	6	10
		Medial	6	10
2	/kʰ/	Initial	1	7
		Medial	1	4
3	/g/	Initial	2	6
		Medial	6	10
4	/gʰ/	Medial	1	4
5	/ŋ/	Medial	6	10
6	/tʃ/	Initial	6	10
		Medial	6	10
7	/tʃʰ/	Initial	3	10
8	/dʒ/	Initial	6	10
		medial	6	10
9	/ɲ/	initial	3	7
		medial	6	7
10	/ʈ/	initial	6	10
11	/ʈʰ/	medial	4	10
12	/ɖ/	initial	5	10
		medial	6	10
13	/ɳ/	initial	6	9
		medial	6	10
14	/t̪/	initial	6	10
		medial	5	8
15	/t̪ʰ/	medial	4	10
16	/d̪/	initial	5	10
		medial	4	7
17	/d̪ʰ/	medial	3	5
18	/n̪/	initial	5	10
19	/p/	initial	6	10
		medial	6	10
20	/b/	initial	6	10
		medial	6	10
21	/bʰ/	initial	0	7

Sl. No	Phonemes	Word positions	Age groups	
			>4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
22	/m/	initial	6	10
		medial	6	10
		final	6	10
23	/j/	initial	5	9
23	/j/	medial	6	10
24	/ɾ/	initial	4	10
		medial	5	10
25	/l/	initial	4	10
		medial	2	10
		final	6	10
26	/v/	initial	6	10
		medial	6	10
27	/ʃ/	initial	5	9
		medial	4	10
28	/ʂ/	initial	3	8
		medial	2	9
29	/s/	initial	6	10
		medial	6	10
30	/h/	medial	4	9
31	/ɭ/	medial	5	8
		final	4	8
32	/ɻ/	medial	6	7
33	/r/	initial	5	9
		medial	3	9
		final	6	10
34	/f/	initial	6	10
35	/t/	medial	6	9

Table 4.2

Shows the number of children with correct production of English consonants

Sl. No	Phonemes	Word positions	Age groups	
			>4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
1	/h/	initial	5	8
2	/d/	initial	6	10
		medial	6	10
		final	6	10
3	/p/	initial	6	10
		medial	6	10
		final	6	10
4	/k/	initial	6	10
		medial	6	10
		final	6	10
5	/b/	initial	5	10
		medial	6	10
6	/g/	initial	6	10
		medial	6	10
		final	6	10
7	/t/	initial	6	10
		medial	6	10
		final	6	10
8	/m/	initial	6	10
		medial	6	10
		final	6	10
9	/f/	Initial	6	10
		medial	6	10
		final	6	10
10	/w/	initial	6	10
11	/n/	initial	6	10
		medial	6	10
		final	6	10
12	/ʃ/	initial	5	10
		medial	6	10
13	/s/	Initial	6	10
		medial	6	10
		final	6	10
14	/r/	initial	6	10
		medial	5	9
		final	6	10
15	/t̪/	initial	4	5
		final	4	5

Sl. No	Phonemes	Word positions	Age groups	
			>4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
16	/v/	initial	6	10
		medial	6	10
		final	6	10
17	/dʒ/	initial	6	10
		medial	6	10
18	/j/	initial	6	8
		medial	5	10
19	/ɖ/	initial	6	6
		medial	5	10
20	/l/	initial	5	10
		medial	6	10
		final	6	10
21	/tʃ/	initial	6	10
		final	6	10
22	/ŋ/	medial	6	10
		final	6	10
23	/z/	initial	6	10
		medial	6	8
		final	6	10

4.1.3 Development of consonant clusters

The present study considered 28 clusters in in Malayalam and 16 clusters in English. The results revealed an increase in the number of children who correctly produced clusters from group 1 to group 2 in both languages. Most common errors in cluster productions were substitution of one or more consonants and coalescence. In English, the number of children who correctly produced same clusters varied across different words. In such cases, words produced by higher number of children were considered. For instance, 2/6 children correctly produced the consonant cluster /br/ in initial position in the word / brʌʃɪŋ/ whereas 3/6 correctly produced the same cluster in initial position in other word / brʌɖər/. Hence the highest production three is considered. The distributions of correct productions of clusters for both age groups in both Malayalam and English are presented in Table 4.3 and 4.4 respectively.

Table 4.3

Shows the number of children with correct production of clusters in Malayalam

Sl. No	Clusters	Word positions	Age groups >4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
1	/nt̪/	medial	5	10
2	/n̪t̪/	medial	6	10
3	/ɲtʃ/	medial	6	9
4	/nd/	medial	6	10
5	/nk/	medial	6	10
6	/lj/	medial	4	10
7	/t̪j/	medial	6	10
8	/kj/	initial	6	10
9	/sk/	initial	5	9
		medial	6	10
10	/gl̪/	initial	5	7
11	/d̪j/	medial	6	9
12	/t̪ɾ/	initial	6	10
13	/pl/	initial	5	10
14	/sl/	initial	5	10
15	/bl/	initial	5	10
16	/st̪ʰ/	initial	5	10
17	/n̪d̪ɾ/	medial	3	9
18	/st̪/	medial	6	9
19	/sp/	initial	5	10
20	/br/	initial	4	10
21	/st̪r/	medial	2	10
22	/t̪r/	medial	2	10
23	/pr/	initial	5	10
24	/kl/	initial	4	10
25	/gɾ/	initial	4	9
26	/ʃʋ/	initial	3	8
27	/kr/	initial	4	7
		medial	4	10
28	/kʂ/	medial	1	1

Table 4.4

Shows the number of children with correct production of clusters in English

Sl. No	Clusters	Word positions	Age groups	
			>4;0-≤4;6 (N=6)	>4;6-≤5;0 (N=10)
1	/kw/	initial	6	10
2	/sp/	initial	3	10
3	/dr/	initial	5	9
4	/pl/	initial	5	10
5	/sl/	initial	5	10
6	/sw/	initial	3	7
7	/br/	initial	3	9
		medial	6	8
8	/bl/	initial	6	10
9	/fr/	initial	5	10
10	/gr/	initial	6	10
11	/pr/	initial	4	6
12	/kr/	initial	4	10
13	/tr/	initial	4	9
14	/st/	initial	5	10
15	/nt/	final	6	10
16	/gl/	initial	6	10

4.2 Speech sound accuracy in Malayalam and English

Statistical analysis was carried out using SPSS (Version 26). The descriptive statistics of Malayalam and English across age groups were analyzed for four articulatory outcome measures, i.e., Consonant/Vowel (CV) accuracy, Whole Word Accuracy (WWA) with Proportion of Whole-word Correctness (PWC), Percentage of Consonants Correct-Revised (PCC-R) and Percentage of Speech intelligibility. The results are depicted in Table 4.5

Table 4.5

Descriptive statistics of the four articulation outcome measures across languages and age groups

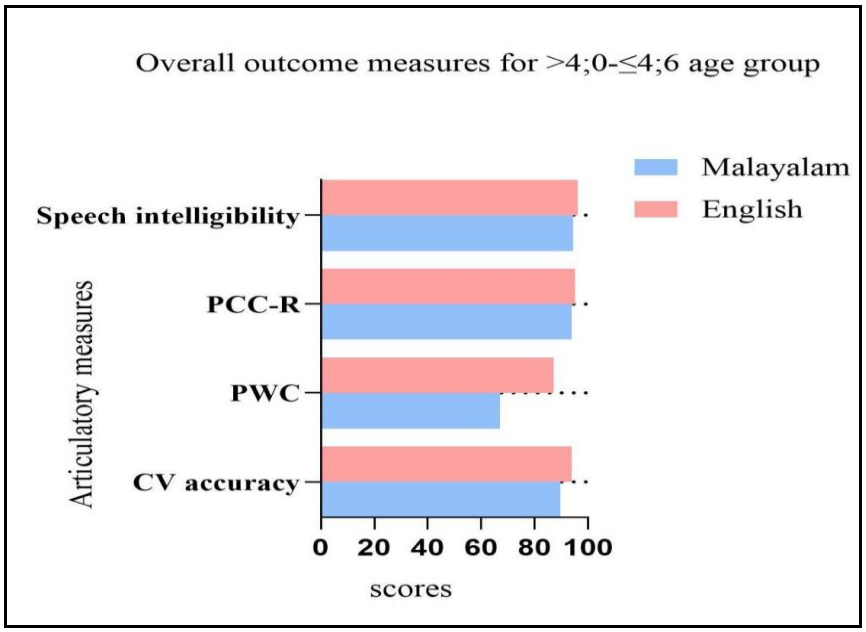
Sl. No	Articulatory outcome measures	Age groups	Median	IQR	Mean	SD
1	CV accuracy - Malayalam	>4;0-≤4;6	89.63	7.81	89.58	5.69
		>4;6-≤5;0	95.50	1.94	95.75	1.21
2	CV accuracy - English	>4;0-≤4;6	93.96	7.71	92.01	4.85
		>4;6-≤5;0	95.83	2.81	95.12	2.13
3	PWC-Malayalam	>4;0-≤4;6	0.67	0.25	0.73	0.14
		>4;6-≤5;0	0.89	0.10	0.88	0.06
4	PWC-English	>4;0-≤4;6	0.87	0.15	0.85	0.09
		>4;6-≤5;0	0.93	0.04	0.92	0.04
5	PCC-R-Malayalam	>4;0-≤4;6	93.86	7.06	94.06	4.01
		>4;6-≤5;0	96.19	5.19	95.38	2.77
6	PCC-R-English	>4;0-≤4;6	95.19	2.73	94.35	1.88
		>4;6-≤5;0	97.54	2.66	96.68	2.11
7	Speech intelligibility-Malayalam (%)	>4;0-≤4;6	94.36	8.58	95.12	4.30
		>4;6-≤5;0	98.00	6.47	97.11	3.21
8	Speech intelligibility-English (%)	>4;0-≤4;6	96.02	8.03	95.99	3.62
		>4;6-≤5;0	100.00	2.85	98.55	2.65

Note: IQR= Inter-quartile range, SD= Standard Deviation CV accuracy= Consonant/Vowel accuracy, PWC= Proportion of Whole Word Correctness PCC-R= Percentage of Consonants Correct-Revised

Table 4.5 reveals a significant improvement across the two age groups in both languages in all the four articulation outcome measures, indicating speech sound accuracy improved with age and the overall results are depicted in figure 4.1 and 4.2

Figure 4.1

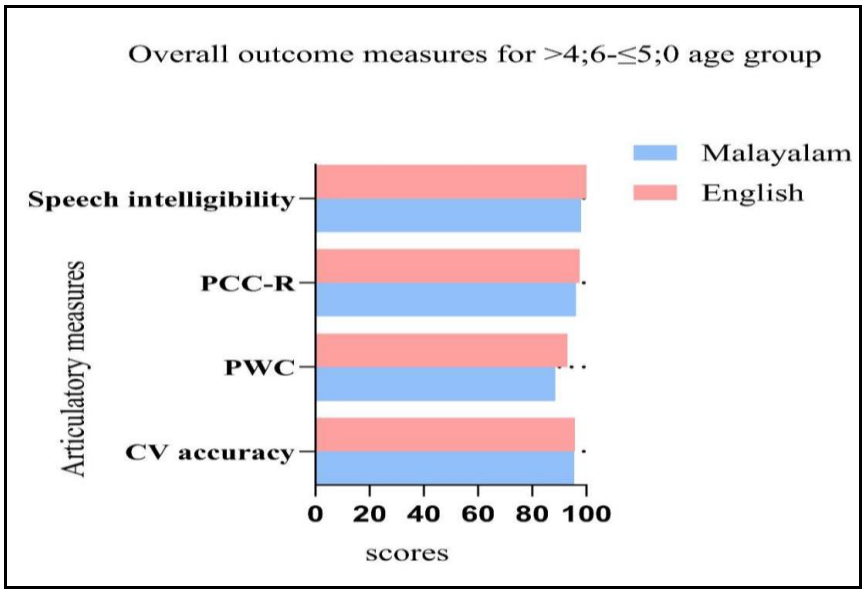
Shows the median of articulation outcome measures for Malayalam and English in the age range of >4;0-≤4;6 years



Note: CV accuracy= Consonant/Vowel accuracy, PWC= Proportion of Whole Word Correctness, PCC-R= Percentage of Consonants Correct-Revised

Figure 4.2

Shows the median of articulation outcome measures for Malayalam and English in the age range of >4;6-≤5;0 years



Note: CV accuracy= Consonant/Vowel accuracy, PWC= Proportion of Whole Word Correctness PCC-R= Percentage of Consonants Correct-Revised

For inter-judge reliability, three speech language pathologists (SLPs) including the researcher transcribed 10% of the data, and calculated all four articulation outcome measures. Similarly, for intra-judge reliability, 10% of the data (2 participants) was reanalyzed by the researcher in a span of one week. No statistical test was employed due to small sample size. However, differences between scores given by three SLPs were within the range of 0.07 points for PWC in Malayalam, 0.05 points for PWC in English. It was within 5% range for other three articulation outcome measures for both participants in both languages. Similarly, differences between two sets of scores assigned by the judge was within the range of 0.05 points for PWC in Malayalam and English and was within 5% range for all other outcome

measures. These findings indicate high inter-judge and intra-judge reliability for all the articulation outcome measures.

4.3 Comparison of speech sound accuracy in Malayalam and English within age groups

Normality of the data was tested using Shapiro Wilk's test to determine appropriate tests for inferential statistics. The findings revealed the data did not follow normal distribution principle ($p<0.05$). Therefore, the non-parametric Wilcoxon Signed Rank test was employed to determine the significant difference between L1 and L2 in the group 1 >4;0 to ≤ 4;6 years as depicted in Table 4.6

Table 4.6

Statistical comparison of articulation outcome measures across both languages for participants in the age range of >4;0 to ≤ 4;6 years

Articulatory measure	/z/ value	p value
CV accuracy (Malayalam vs English)	1.992	.046*
PWC (Malayalam vs English)	2.207	.027*
PCC-R (Malayalam vs English)	0.105	.917
Speech intelligibility (Malayalam vs English)	0.730	.465

Note: *= Significance at .05 level

CV accuracy= Consonant/Vowel accuracy PWC= Proportion of Whole Word Correctness, PCC-R= Percentage of Consonants Correct-Revised

A statistically significant difference was observed between Malayalam and English in CV accuracy and Whole Word Accuracy (WWA) with Proportion of Whole Word Correctness (PWC) in the age range of >4;0 to ≤ 4;6 years. Comparing

the median of both languages in these articulation outcome measures, higher scores were found in English as depicted in Table 4.5, indicating a better articulatory performance in English compared to Malayalam. No statistically significant difference was noticed between PCC-R and speech intelligibility between both languages (p value >0.05), suggesting similar performance in both Malayalam and English. The statistical comparison of L1 vs L2 of the group 2 >4;6 to ≤ 5;0 years is depicted in Table 4.7

Table 4.7

Statistical comparison of articulation outcome measures across both languages for participants in the age group of >4;6 to ≤ 5;0 years.

Articulatory measure	/z/ value	p value
CV accuracy (Malayalam vs English)	0.561	.574
PWC (Malayalam vs English)	2.196	.028*
PCC-R (Malayalam vs English)	2.090	.037*
Speech intelligibility (Malayalam vs English)	1.753	.080

Note: *= Significance at .05 level

CV accuracy= Consonant/Vowel accuracy PWC= Proportion of Whole Word Correctness PCC-R= Percentage of Consonants Correct-Revised

A statistically significant difference was observed between Malayalam and English in Whole Word Accuracy (WWA) with Proportion of Whole Word Correctness (PWC) and PCC-R in the age range of >4;6 to ≤ 5;0 (p value of <0.05). Comparing the median of both languages in these articulation outcome measures, higher scores were found in English as depicted in Table 4.5, indicating a better articulatory performance in English compared to Malayalam. However, no

statistically significant difference was noticed in CV accuracy and speech intelligibility between both languages, suggesting similar performance in both Malayalam and English.

4.4 Comparison of speech sound accuracy across age groups for Malayalam and English

Comparison of articulatory outcome measures across the two age groups for both languages separately for the simultaneous bilingual children were carried out using SPSS (version 26). As the data did not follow normal distribution, non-parametric Mann-Whitney U test was employed to determine the significant difference if any. The results of Mann-Whitney U test are depicted in Table 4.8.

Table 4.8

Statistical comparison of articulatory outcome measures across the two age groups in both languages

Articulatory outcome measures	/Z/ value	P value
CV acc. Malayalam	2.392	0.016*
CV acc. English	1.383	0.181
PWC Malayalam	2.064	0.042*
PWC English	1.754	0.093
PCC-R Malayalam	0.759	0.492
PCC-R English	2.225	0.022*
Sp. intelligibility. Malayalam	1.133	0.313
Sp. intelligibility. English	1.554	0.181

Note: *= Significance at 0.05 level

CV accuracy= Consonant/Vowel accuracy, PWC= Proportion of Whole Word Correctness, PCC-R= Percentage of Consonants Correct-Revised

A statistically significant difference was noticed between CV accuracy and Whole Word Accuracy (WWA) with Proportion of Whole Word Correctness (PWC) in Malayalam and PCC-R in English across the two age groups. Comparing the median scores of the two age groups i.e., >4;0 to ≤ 4;6 years and >4;6 to ≤ 5;0, higher scores for median was found in the older age groups for these parameters, indicating a better performance by the group 2 compared to the group 1. No statistically significant difference was observed for other articulation outcome measures indicating similar performance by the two age groups.

Overall, the results revealed that speech sound accuracy of Malayalam-English simultaneous bilingual improved with age and a better performance was found in English for all the articulation outcome measures compared to Malayalam. The results are discussed in the next section.

Chapter V

DISCUSSION

The purpose of the present study was to investigate the speech sound developmental pattern and accuracy of Malayalam-English simultaneous bilingual children in the age range of 4-5 years. The study considered a total of 16 participants who were divided into two subgroups with a six months age interval i.e., >4;0 to ≤4;6 years (Group 1) and >4;6 to ≤5;0 years (Group 2) with 6 participants and 10 participants respectively. The speech samples of the children were collected through administration of articulation tests and story narration samples from both languages. Four articulation outcome measures were assessed; 1) Consonant/Vowel accuracy 2) Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC), 3) Percentage of Consonant Correct- Revised (PCC-R) and 4) Percentage of speech intelligibility. The first two measures were assessed using MAT-R (Neenu et al., 2011) in Malayalam and GFTA-3 (Goldman & Fristoe, 2015) in English. The following two measures were assessed through narration sample of a familiar story 'The Thirsty Crow'. The results obtained from the current study are discussed under the following headings:

5.1 Speech sound development in Malayalam-English simultaneous bilingual children

5.2 Speech sound accuracy in Malayalam-English simultaneous bilingual children

5.1 Speech sound development in Malayalam-English simultaneous bilingual children

5.1.1 Development of vowels

A total of 10 vowels in Malayalam and nine vowels and three diphthongs were tested in English in the present study and the findings indicated that Malayalam-English simultaneous bilingual children followed a similar pattern in speech sound

development compared to monolingual peers of both languages. All vowels and diphthongs of both languages were found to be fully acquired by all participants by the age of >4;0 - ≤4;6 years. This finding is substantiated by several prior studies on both bilingual and monolingual speech sound development showing an earlier acquisition of these sounds.

Lim and Chieng (2022) noted that English-Malay simultaneous bilingual children mastered vowels by 2;11 years in both languages and vowel phonological patterns were rare after the age of 3 years. Similarly, Lee (2020) found all vowels are acquired by 3;0-3;6 years of age in Korean-English simultaneous bilingual children.

More recent studies on monolingual speech sound development also reflect an earlier acquisition of vowels. Vowels were fully acquired even before 3 years of age in both Malayalam (Divya & Sreedevi, 2010; Maya & Savithri, 1990; Neenu et al., 2011) and in English (Dodd et al., 2003; Holm, 2022).

The present study is in coherence with the above-mentioned studies. Notably, the current study considered children from 4;0 years of age onwards, hence it is suggested that vowels and diphthongs may be acquired at a much earlier age in Malayalam-English simultaneous bilingual children.

5.1.2 Development of consonants

Considering the development of consonants, the present study considered 35 consonants in Malayalam and 23 consonants in English. It was identified that the number of children who correctly produced each phoneme increased from younger to older age group for all phonemes in both languages.

Group 1 (>4;0 to ≤ 4;6 years): All the unaspirated speech sounds, except a few were correctly produced by at least five participants of this age group in both Malayalam

and English. It was noted that some consonants were correctly produced by all 6 participants and also none of the participants produced aspirated phonemes in this age group. The detailed findings are depicted in Table 4.1 and 4.2. These findings may indicate that majority of the consonants are mastered by 4;6 years of age in simultaneous bilingual children. However, it should also be noted that as the present study considered participants from 4;0 years onwards, similar findings of mastery are highly plausible even if younger groups were considered.

Group 2 (>4;6 to ≤ 5;0 years): In both Malayalam and English, all the unaspirated speech sounds, except a few were correctly produced by at least nine participants of this age group. It was noted that some consonants and few voiceless aspirated phonemes such as /tʃʰ/, /t̪ʰ/ and /ʈʰ/ were correctly produced by all 10 participants. The detailed findings are depicted in Tables 4.1 and 4.2. The findings indicate that majority of consonants in both languages were fully developed by 4-5 years of age in Malayalam-English simultaneous bilingual children.

Similar results can be found in bilingual studies of other languages also. Lim and Chieng (2022) found that most of the phonemes were acquired by 4;06 years of age in English-Malay simultaneous bilingual children. Previously, Gildersleeve-Neumann et al. (2008) observed that majority of the consonants except affricates were acquired by 3 years of age in Spanish-English bilingual children.

Comparing the findings with prior studies, the pattern of acquisition in bilinguals was greatly consistent with the monolingual speech sound development. Fricative /h/ and aspirated phonemes such as /tʃʰ/, /t̪ʰ/ and /ʈʰ/ were found to be acquired earlier in Malayalam in the present study, i.e., by 5 years, compared to by 6 years, as reported by Neenu et al. (2011). This earlier acquisition of /h/ may be

attributed to increased exposure of this phoneme in both languages, greater frequency of occurrence in everyday communication and the influence of bilingual phonological input. Notably, despite the rare use of aspirated phonemes in the colloquial language, voiceless aspirated stops were produced by all children in the older age group, which could be because of phoneme specific characteristics and ease of production compared to voiced aspirated stops.

However, Malayalam specific sounds /ɲ/ and /ɭ/ were not correctly produced by all children by 5 years which is contrary to findings in monolingual children, where these sounds were reported to be acquired by 4 years (Neenu et al., 2011). This may be primarily attributed to the unfamiliarity with the words used in the articulation tests. For instance, while testing /ɲ/, stimulus word in MAT-R was /ɲaɳʈ/ (meaning Crab) is a less used word and is mostly replaced by its English equivalent 'crab' in the recent years. This is especially true for the bilingual children due to their increased exposure to English in everyday communication. Additionally, the frequency of occurrence of the above-mentioned sounds is lower in Malayalam, as substantiated by Sreedevi and Irfana (2013). They reported that /ɲ/ and /ɭ/ occurred less frequently in Malayalam compared to other nasals and laterals.

Balanced simultaneous bilingual children of the current study had the influence of English on their production of Malayalam consonants; where rhotic consonants were produced without trilling, possibly due to increased use of English in daily communication. A similar finding was reported by Harini and Shyamala (2008), who observed that the insertion of English lexemes to Kannada was more frequent than Kannada lexemes into English.

Such findings regarding the influence of one language on the other have been reported in studies on bilingual speech sound development. Frequent gliding of /l/ and

/ɹ/ were found in English-Spanish balanced bilinguals, suggesting influence of Spanish in the allophones of English (Gildersleeve-Neumann et al., 2008).

In the current study, majority of the English phonemes were found to be correctly produced between 4-5 years of age, which can be attributed to early and increased exposure to English through everyday communication, in school and media via cartoons. This is consistent with the observations of Gildersleeve-Neumann and Wright (2010) where they found early developing English consonants were produced by all Russian-English children, along with a comparable frequency of production of later developing sounds in both Russian-English bilingual and English-speaking monolingual children aged 5 years.

5.1.3 Development of consonant clusters

In the current study, 28 clusters in in Malayalam and 16 clusters in English were considered. Number of consonant clusters correctly produced by children increased from younger to older age groups in both languages. The detailed findings are depicted in Table 4.3 and Table 4.4.

Correct production of consonant is clusters found to be distinct in simultaneous bilingual children compared to monolingual studies in Malayalam. A few later developing clusters (/pr/, /sp/, /st̪/) in Malayalam were produced by 5 years of age in bilingual children of this study, whereas these were reported to be acquired by 5-6 years in monolingual children (Neenu et al., 2011). However, few earlier developing clusters (/lj/) in monolingual children were found to be later developing in bilingual children of this study, which is a finding congruous with Gildersleeve-Neumann et al. (2008) where bilingual children did not master consonant clusters by 4 years unlike monolinguals. Hence, the findings could be attributed to the differences in phonological exposure, cross-linguistic influence and variability in bilingual speech

sound development. Overall, these observations suggest both positive and negative transfer across languages.

Medial clusters were found to be correctly produced by all children more frequently compared to initial clusters in Malayalam, i.e., eight out of 14 medial clusters were produced by all 16 participants whereas only two of the 13 initial clusters were correctly produced. This could be attributed to the higher frequency of occurrence of medial clusters in Malayalam compared to initial clusters which is consistent with the findings of Indian monolingual speech sound development studies (Alphonsa & Sreedevi, 2012; Asin et al., 2024; Divyashree & Sreedevi, 2018; Neenu et al., 2011; Sneha & Sreedevi, 2012)

Another interesting finding was the earlier production of shared consonant clusters such as /pl/, /gl/ which may be attributed to the presence of these clusters in both languages, resulting in increased exposure and reinforcement across bilingual environments demonstrating a positive transfer between languages. Similar findings can be seen on speech sound accuracy where shared consonants and clusters were produced more accurately compared to unshared phonemes (Meziane & MacLeod, 2021; Montanari et al., 2018).

5.2 Speech sound accuracy in Malayalam-English simultaneous bilingual children

Other major objectives of the study were to investigate the speech sound accuracy of Malayalam-English simultaneous bilingual children and compare this across languages and age groups. The findings revealed a remarkable improvement in speech sound accuracy with increasing age in both languages in all articulation measures, suggesting progression towards a complete phonological system.

Additionally, the boost in the speech sound accuracy was more marked in English than in Malayalam, especially for whole word accuracy.

Previous studies have arrived at similar findings on the speech sound accuracy of bilingual children, where one language performs better. Montanari et al. (2018) observed a significant increase in the consonant and cluster accuracy of pre-school aged Spanish-English bilingual children in both languages, within a span of one year and a more pronounced growth was found in English compared to Spanish which they attributed to increased input to English at school settings.

Correspondingly, Lee (2020) reported that simultaneous bilingual children produced phonemes of the dominant language (English) more accurately than phonemes of less dominant language (Korean) even across the similar categories (stops, affricates, etc.) suggesting a larger phoneme size and complexity of Korean. Gildersleeve-Neumann et al (2008) also revealed that English-Spanish balanced bilingual children demonstrated increased speech sound accuracy overtime and the children who had greater exposure to English had fewer errors on average. Debski et al (2022) reported more correct production of vowels and consonants and fewer phonological error patterns in Polish compared to Ukrainian, demonstrating stronger phonological skills in Polish.

Comparing the results of current study with the aforementioned studies, it can be suggested that simultaneous bilingual children do possess distinct phonological systems for each language, yet these two systems are interdependent, as indicated in 'Interactional Dual System Model-IDSM' (Paradis, 2001). One probable explanation for the better performance in English in the present study would be the increased exposure to English in everyday life through school and media as well as the greater phonetic complexity of Malayalam. It should be noted that whole word accuracy

significantly differed consistently across languages and age groups, with higher accuracy observed in English and improved performance with increasing age. This could be ascribed to greater familiarity to English words compared to Malayalam and improved motor skills with age. Another probable reason is WWA with PWC assesses the accuracy of all phonemes in the stimulus word and not just the target phonemes as in CV accuracy and PCC-R scores.

Comparing the findings with monolingual groups, the PCC-R scores in English showed similarities to monolingual children of age 4-5 years. Dodd et al (2003) reported PCC scores of 90.29 for girls and 90.46 for boys in children aged 4;0-5;5 years and consistent improvement was observed with increasing age. Although gender-wise comparison was not carried out in the current study, the PCC-R scores increased from 95.18 in >4;0 to ≤ 4;6 years to 97.54 in >4;6- ≤5;0 years, suggesting comparatively better speech sound accuracy in bilinguals than monolinguals in English.

Hustad et al (2021) found that the mean speech intelligibility score for multiword utterances in monolingual English children aged 48-59 months (4-5 years) was 83.2% and they suggested that it is not expected for an average child to achieve 90% speech intelligibility until approximately 5 years. However, in the present study, the mean speech intelligibility scores in English increased from 95.98% in 4;0-4;6 years to 98.54% in 4;6-5;0 years. These findings may indicate that exposure to multiple phonological systems may enhance the sensitivity to speech sounds and improve articulatory accuracy suggesting a positive transfer. This finding also supports an earlier study by Shishira et al. (2010) on speech intelligibility of Kannada speaking toddlers reporting 85% by 3.3 years and near 100% by 4 years of age even to strangers.

Despite the absence of comparable Malayalam monolingual data on all outcome measures, the consistently high performance in both languages may indicate that bilingual exposure is not associated with significant delays in speech sound development and accuracy in these children.

Several studies across the globe harmonize with this assumption. Fabiano-Smith and Barlow (2010) observed that 3-4 years old Spanish-English bilingual children acquired phonetic inventory of both languages at the same time as monolingual acquire one inventory with evidences of bidirectional transfer. Lin and Johnson (2010) indicated that phonological patterns and phoneme accuracy of Mandarin-English sequential bilingual children of 4-5 years of age were similar to their monolingual peers. Fuenzalida-Muñoz (2025) suggested that Spanish-Valencian bilinguals showed earlier acquisition of phonemes depending on the sound and interaction between languages and complex relationship exists between language input and bilingualism.

However, few studies have reported contradictory findings wherein bilingual children demonstrated weaker phonological skills and development compared to their monolingual peers. For instance, Gildersleeve-Neumann et al. (2008) found that 3–4-year-old Spanish-English bilingual children showed higher error patterns compared to monolingual children and suggested that higher error rates are likely typical for bilingual children.

Fabiano-Smith and Goldstein (2010) observed that consonant accuracy in Spanish was lower for bilingual children than their Spanish monolingual peers. Also, the rate of acquisition of phonological accuracy was somewhat slower but within the normal limits.

Overall, Malayalam-English simultaneous bilingual children in the current study demonstrated similar pattern of speech sound development as monolingual peers. The minor differences observed between Malayalam and English may reflect bilingual language interaction rather than clinically significant delays. This understanding is crucial in the speech sound assessment of bilingual children to avoid misdiagnosis. The findings further indicate that simultaneous bilingual exposure does not appear to adversely affect speech sound development in these children.

Chapter VI

SUMMARY AND CONCLUSIONS

Bilingualism refers to the proficient use of two languages. It encompasses wide range of language acquisition scenarios, including simultaneous bilingualism which involves the concurrent acquisition of two languages since birth or within the first few years of life. This can impact speech sound development uniquely compared to monolingual children. The phonological systems of both languages develop in parallel with some cross linguistic interaction in simultaneous bilingual children. This can result in variations in timing and pattern of speech sound development, influenced by the phonetic and phonological properties of each language and the amount of exposure the child receives to each language.

In the context of Malayalam-English bilingualism, children acquire two linguistically distinct languages simultaneously. The relevance of speech sound development in bilingual children is significant for several reasons. First, accurate speech sound development is foundational for effective communication and literacy skills in both languages. Second, understanding typical speech sound pattern in bilingual children helps distinguish between language differences due to bilingualism and speech sound disorder preventing misdiagnosis and inappropriate intervention. However, there is notable absence of studies on bilingual speech sound development in the Indian context. Hence, the present study aimed to investigate the speech sound development and accuracy in Malayalam-English simultaneous bilingual children aged 4 to 5 years. The main objective of the study was to compare speech sound accuracy of the both languages within and across age groups.

The participants were divided into two subgroups i.e., >4;0 to ≤ 4;6 and >4;6 to ≤ 5;0 years with 6 participants in the first group and 10 children in the second

group comprising a total of 16 participants. The speech samples were collected through two articulation tests, i.e., MAT-R (Neenu et al., 2011) in Malayalam and GFTA-3 (Goldman & Fristoe, 2015) in English and story narration sample of a familiar story 'Thirsty Crow' in both languages. Four articulation outcome measures were assessed; Consonant/Vowel accuracy and Whole word correctness (WWA) with Proportion of Whole Word Correctness (PWC) using articulation tests and Percentage of Consonant Correct-Revised (PCC-R) and Percentage of speech intelligibility using the story narration sample.

Phoneme-wise analysis was carried out to identify the number of children who correctly produced the speech sounds in both languages and across age groups. The findings indicated that all vowels and diphthongs of both languages were correctly produced by all 6 participants by >4;0 to ≤ 4;6 years of age, consistent with the previous studies. Similarly, the number of children who correctly produced the consonants increased from younger age group to the older age group.

In Malayalam, most of the phonemes except few fricatives, liquids and aspirated phonemes were produced correctly by all 6 participants in the younger group. However, these phonemes had correct production for at least 9 participants in the older group of >4;6 to ≤ 5;0 years. In English, the Indian version of dental fricatives /θ/, /ð/ (dental stops) were produced as retroflex by the younger group but were corrected by the older group of participants. However, there were some language specific variations observed in both groups. Simultaneous bilingual children showed the influence of English on their production of Malayalam consonants particularly the trills had a rhotic flair.

Number of children who produced consonant clusters also increased with age in both languages. Overall, majority of English phonemes and clusters were correctly

produced by 5 years compared to Malayalam which may be attributed to the increased exposure to English in everyday life of the participants.

For the statistical analysis, as the data was not normally distributed, non-parametric tests were employed. Wilcoxon Signed Rank test was applied to compare the speech sound accuracy between the languages in both age groups. A statistically significant difference was observed between Malayalam and English in CV accuracy and Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC) in the age range of >4;0 to ≤ 4;6 years. Similarly, a statistically significant difference was observed between Malayalam and English in Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC) and PCC-R in the age range of >4;6 to ≤ 5;0 years, suggesting a better performance in English compared to Malayalam.

Mann-Whitney U test was applied to compare the speech sound accuracy across the two age groups in both languages. A statistically significant difference was noticed between CV accuracy and Whole Word Accuracy (WWA) with Proportion of Whole-Word Correctness (PWC) in Malayalam and PCC-R in English across age groups, showing a better performance by the older age group. The overall findings indicated that speech sound accuracy of Malayalam-English simultaneous bilingual is improving with age and a better performance was found in English for all the articulatory outcome measures considered in the study compared to Malayalam.

Implications of the Study

- The study provides a preliminary normative data for speech sound development in Malayalam-English simultaneous bilingual children in the age range of 4-5 years

- The findings assist Speech - Language Pathologists in distinguishing between typical bilingual development patterns and speech sound disorders, reducing risk of misdiagnosis
- The results provide a baseline for linguistically appropriate articulation assessment tools tailored to Malayalam-English speaking bilinguals.
- Help in appropriate intervention planning considering bilingual factors such as dominant language, exposure to each language etc.
- The study supports parent counselling by providing evidence-based explanation of bilingual speech sound development, reducing anxiety.

Limitations of the Study

- A clear acquisition criterion for bilingual children could not be established due to small number of participants
- The two groups of the study did not have equal number of participants (6 in younger group and 10 in older group) due to logistic constraints
- Observations on earlier developmental changes in speech sound development was limited as the study considered 4-5 years old children only.
- The study lacked a control group i.e., monolinguals.
- The participants had different onset of exposure to both languages leading to variations in the proficiency.
- Lack of standardized Indian English IPA created difficulties during data analysis.

Future Directions

- The study can be replicated with a more number of participants

- The study can include younger age groups (below 4 years) of simultaneous bilingual children in order to obtain a more accurate speech sound development pattern.
- The study can be replicated including monolinguals as control group
- More uniformity can be maintained in participant selection with reference to exposure to different languages
- Spontaneous speech sample can be used instead of familiar story narration to assess speech intelligibility for reducing task bias
- The study can be further extended to bilingual children in other Indian languages
- Bilingual speech sound development can be established in clinical groups such as Speech sound disorder, Hearing impairment, Intellectual Disability etc.

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Appendix A

WHO Ten-Question Disability Screening Checklist (Singhi et al., 2007)

1. Compared with other children, did the child have any serious delay in sitting, standing or walking?
2. Compared with other children does the child have difficulty seeing, either in the daytime or at night?
3. Does the child appear to have difficulty hearing?
4. When you tell the child to do something, does he/she seem to understand what you are saying?
5. Does the child have difficulty in walking or moving his/her arms or does he/she have weakness and/or stiffness in the arms or legs?
6. Does the child sometimes have fits, become rigid, or lose consciousness?
7. Does the child learn to do things like other children his/her age?
8. Does the child speak at all (can he/she make himself/herself understood in words; can he/she say any recognizable words)?
9. For 3 to 9 year olds ask: Is the child's speech in any way different from normal (not clear enough to be understood by people other than his/her immediate family)? For 2 year olds ask: Can he/she name at least one object (for example, an animal, a toy, a cup, a spoon)?
10. Compared with other children of his/her age, does the child appear in any way mentally backward, dull or slow?

Appendix B

Questionnaire for parents (Shanbal & Prema, 2007)

(Used for assessing children's language proficiency)

QUESTIONNAIRE FOR PARENTS

Note: Dear Parents the purpose of this questionnaire is to survey children who use two or more than two languages at school and at home. Read each statement carefully and then answer them.

Name of child: Date:

Age/Sex: Grade:

School:

Father's Name: Phone:

Mother's Name:

Address:

Any significant medical history:

The purpose of this questionnaire is to survey children who use two or more than two languages at school and at home.

Read each statement carefully and then answer them:

- Mother Tongue:
- Medium of instruction at school:

1) Language used for communication at school (Please specify):

Most of the time	Sometimes	Always

2) Language used for communication at home (Please specify):

Most of the time	Sometimes	Always

3) Languages spoken by the child (Please specify):

Most of the time	Sometimes	Always

4) Languages spoken by the family members at home (Please specify):

Most of the time	Sometimes	Always

5) Languages used by the family members to teach literacy skills at home (Please specify):

Most of the time	Sometimes	Always

6) Languages used at school to teach literacy skills (Please specify):

Most of the time	Sometimes	Always

- Languages known by the child :
- Languages taught as subjects at school:
- Language preference of the child (if any) at school and at home:
- Best performance of the child in any particular language at school (For e.g., performs better in language subjects like English or Kannada):

Overall performance of the child in the class:

Poor	Average	Good

Appendix C

Information and Participant Consent Form

Information to parents/ teachers of participants in the study:

I, Ms. Neelima N, studying MSc in Speech-Language Pathology at the All India Institute of Speech and Hearing, Mysuru, is conducting a study titled ***"Speech sound development in typically developing Malayalam-English simultaneous bilingual children"*** as part of my Dissertation under the guidance of Dr. N Sreedevi, Professor of Speech Sciences and Chairperson C-PECD, AIISH, Mysuru. You are invited to participate in this study, which involves recording of speech sample. The total duration of this recording will take up to 20-30 minutes per child. Responses will be documented for analysis purposes. The data obtained from the participants will not be disclosed, and access will be limited to individuals working on the study. Participation in this study is voluntary. You can refuse to participate or withdraw at any point in the study without penalty or loss of benefits to which you are otherwise entitled.

INFORMED CONSENT

I have been informed about the study's aims, objectives, and procedure. I have read the foregoing information, or it has been read to me in the language I understand. I have had the opportunity to ask questions about it, and any questions I have asked have been answered satisfactorily. I consent voluntarily for my child to participate in this study.

I, _____, the undersigned, give my consent for my child to be a participant in this investigation/study.

Signature of the Parent: **Signature of the investigator**

Name & Contact No: **Name of the investigator:**