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

AGRAJA K

Registration No: P01II24S123003

A Dissertation submitted in part fulfilment of the

Degree of Master of Science

Speech-Language Pathology

University of Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING, NAIMISHAM CAMPUS, MANASAGANGOTHRI, MYSORE-570006

June 2026

CERTIFICATE

This is to certify that this dissertation entitled **"Speech Sound Development in Typically Developing Kannada-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 P01II24S123003. 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.

Mysuru
8th June, 2026

M. Pushpavathi

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 Kannada-English Simultaneous Bilingual Children"** has been prepared under my supervision and guidance. It is also being 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
Department of Speech-Language Sciences
All India Institute of Speech and Hearing
Manasagangothri, Mysuru-570 006

डॉ. एन. श्रीदेवी / Dr. N. Sreedevi
प्रोफेसर आफ स्पीच साइन्स / Professor of Speech Sciences
स्पीच साइन्स विभाग / Department of Speech-Language Sciences
अखिल भारतीय वाक् श्रवण
All India Institute of Speech a
/ Manasagangothri
मैसूरु / Mysuru-570 006

DECLARATION

This is to certify that this dissertation entitled **"Speech Sound Development in Typically Developing Kannada-English Simultaneous Bilingual Children"** is the result of my own study under the guidance of Dr. N Sreedevi, Professor of Speech 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.

Mysuru
June, 2026

Registration no. P01II24S123003

ACKOWLEDGEMENTS

First and foremost, I express my sincere gratitude to Almighty God for the abundant blessings, guidance, and strength throughout the completion of this dissertation.

*I would like to convey my heartfelt gratitude to my family-**Amma, Amooma, Aju and Amrith** for their encouragement, understanding, and continuous support. Their faith in me has been a constant source of motivation and strength throughout my studies.*

*I extend my deepest gratitude to my dissertation guide, **Dr N Sreedevi**, for the invaluable guidance, expert suggestions, constructive criticism, and continuous encouragement provided throughout the course of this study. Your patience, support, and academic expertise have greatly contributed to the successful completion of this dissertation.*

*I would also like to express my sincere thanks **to Dr M.Pushpavathi** for permitting me to carry out this dissertation.*

*I extend my sincere thanks to **Dr Vasanthalakshmi** and **Dr Sahana** for their assistance and guidance for the study, and I am deeply grateful to **Dr Mamatha** for her valuable guidance in statistical analysis.*

*I am truly grateful to **Ajish sir, Santhi maam, Sahana maam, Prathima maam, Deepa maam, Jesnu sir, Nagashreya maam,** and **Sneha maam** for all the guidance and support. This dissertation would not be complete without them.*

*I am forever thankful to **Ajji, Akki, Neeraja, Paru and Nihala** for being a part of my life from 1st B.Sc. to 2M.Sc. All our bachelor's days, trips, internship days, Chaya kada breaks, everything meant a lot to me. I wish our friendship continues even though we are parting our ways from AIISH. Thank you for making my life in AIISH and Kapila much easier and tolerable. I hope I will remember all our chaotic moments till the end.*

*I thank **Vaishnavi, Amal, Nandu, Aswin, Eshvar, Ajith, MAD HEADS**, and all my section A and B friends from both SLP and Audio for making my life more vibrant and energetic.*

*I thank my seniors **Shyam, Vismaya chechi** and **Swalih sir** for guiding me throughout my academic and clinical journey, and for providing the needed support. I truly appreciate your efforts. Thanks to Jerusha maam as well for all the concerns.*

*I can't believe I'm saying this, but I thank **Thafsal** for introducing me to this course and college and for saving me from many interactive sessions from seniors (who were her classmates) in my bachelors. I still remember the day I had to call you ma'am.*

*I would like to thank my juniors **DAPANS,** for being a great stress buster and a good neighbour. I am grateful to have you people around. I also thank **Fresh makkal** team and all my other juniors who supported and encouraged me to finish my dissertation.*

*My dissertation partner **Neelima** had been my constant support, stress reliever and my secret co-guide who helped me in all ways to complete this dissertation. I will never forget how much we stressed about finding participants and the journey we had to take to get them. It was such a fun and chaotic experience. I am sure I will never forget the hardships.*

I would like to thank my friends and classmates again for their constant encouragement, support, and companionship throughout this academic journey. Their motivation and assistance have helped me overcome various challenges during the completion of this work.

*How can I forget my best friends from my hometown who have been with me since my school days- **Anagha (Minnu)** and **Anjali (Koora)**- for never breaking this friendship and continuously checking on me. I am happy to complete my course and come back to you both so that I can see you and chit-chat like always.*

*I thank **Sanju** for constantly dealing with my stress and for trying to help me in all ways possible. It meant a lot to me.*

*I am thankful to the special guest who came to Kapila one day, screamed till he lost his voice, and continued to melt all our hearts with his cuteness- my dear **Suttu (Suttappan)**. He was the ultimate stress killer (and rat killer). I thank you with all my heart and wish I could continue to keep you and love you till the end.*

My sincere appreciation goes to all the participants and their parents who willingly took part in this research. Their cooperation and valuable contributions made this study possible. I also extend my gratitude to the concerned authorities and institutions for granting permission and facilitating the data collection process.

I am also grateful to all those individuals who have directly or indirectly contributed to the successful completion of this dissertation.

*I thank my precious batch **ECHO** and **CELESTIALS** for making my college life such a wonderful experience. Hope we will keep in touch.*

Last but not least, I thank myself for believing in myself and completing this dissertation. I dedicate this dissertation to myself, for pushing forward even when it was not easy, and for never giving up on this goal. This work stands as a reflection of my effort, strength, and personal growth.

Thank you.

TABLE OF CONTENT

s

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF FREQUENTLY USED ABBREVIATIONS

CV accuracy- Consonant/Vowel accuracy

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

KDPAT –Kannada Diagnostic Picture Articulation Test

PCC-R –Percentage of Consonants Correct

PWC-Proportion of Whole Word Correctness

WWA-Whole Word Accuracy

SODA-Substitution, Omission, Distortion, Addition

ABSTRACT

This study investigated speech sound development and phoneme accuracy in typically developing Kannada English simultaneous bilingual children aged 4 to 5 years (N=16) divided into two age subgroups: group 1 (>4:0 to ≤4:6 years) and group 2 (>4:6 to ≤5:0 years) with eight participants in each group. Articulatory outcome measures such as Consonant Vowel accuracy (CV), Whole Word accuracy (WWA) and Proportion of Whole Word Correctness (PWC), Percentage of Consonant Correct- Revised (PCC-R) and Percentage of Speech Intelligibility were used in the study. Speech samples were elicited through Standardised articulation tests (part I of KDPAT (Deepa & Savithri, 2010) and GFTA-3 (Goldman & Fristoe, 2015)) and a common story narration task in both Kannada and English. Results revealed that all vowels and diphthongs in both Kannada and English were correctly produced by all participants in Group 1, indicating early vowel mastery in bilingual development. Most singleton consonants were also produced with high accuracy in both languages. For the few articulatory errors present, substitution was the most common error type followed by distortion and then omission. Later developing sounds such as /r/, /ʃ/, /s/, and /h/ in Kannada and /r/, /j/ in English displayed greater variability in the younger group but were improved in the older group. Across all four outcome measures, performance was near ceiling for both languages with median values typically ranging from 98% to 100% for CV accuracy, PCC-R, and Speech intelligibility, and high PWC values (approximately 0.90 to 0.90). Inferential analyses using Wilcoxon Signed Ranked test revealed a significant cross linguistic difference only in PWC for Group 1 where English PWC (median=0.97) was higher than Kannada PWC (median= 0.90, z= 2.117, p=0.034). This asymmetry resolved in Group 2 where no significant language differences were observed across measures. Mann Whitney U test showed no significant differences between the two age groups on any outcome measures, suggesting comparable performance in the 4 to 5-year age interval. This finding suggests an early acquisition of all

phonemes by the age of four years itself. Overall, the findings indicate that Kannada English simultaneous bilingual children demonstrate high and broadly typical speech sound development. It is also inferred that the bilingual error patterns particularly the substitution in English is due to the influence of Kannada, reflecting cross linguistic transfer rather than delay or disorder. The study provides a preliminary benchmark for clinical assessment of this under-researched population in the Indian context and supports the importance of evaluating both languages in simultaneous bilingual children to avoid misdiagnosis.

Key words: Kannada English bilingual children, Simultaneous bilingual children, Speech sound development, speech sound accuracy

Chapter I

INTRODUCTION

Speech sound development is the process by which children acquire the ability to produce the sounds of their native language in an orderly and predictable sequence, where maturation of both motor and linguistic skills is involved. Development of speech sounds in children who are typically developing has been extensively studied, yet there remains a considerable gap in our understanding of this process among bilingual populations, especially those from diverse linguistic backgrounds.

Bilingualism refers to the ability of an individual to use two languages proficiently in both spoken and written forms of communication. According to the timing of acquisition, bilinguals can be of two types: simultaneous and sequential. Simultaneous bilingualism takes place when a child is raised in an environment where both languages are consistently spoken from birth. In this scenario, the two languages typically serve the same purpose, and the child is introduced to both languages either from birth or shortly thereafter (Kizi, 2025). McLaughlin (1995) suggests that simultaneous bilingualism can develop at any age before the age of three years. Infants are exposed to interactive language use by their parents, siblings, or other adults in their environment. Through engaging in bilingual interactions, the infant learns the fundamental elements of both languages. Sequential or successive acquisition occurs when the first language or the mother tongue, is already established and the second language is learned later, at any age.

Ibuka (1971) highlights the importance of “critical period,” the first three years in a child’s development. During this time, special connections form between brain cells. These connections help neurons communicate. The most active time for forming these connections is from birth to three years old, where 70-80% of the neural connections are made. As these

connections form the brain's abilities grow, and children are expected to have logarithmic development in speech sound acquisition during this period.

McLaughlin (1978, 1984, 1985) proposed age three as the cutoff that differentiates simultaneous and successive bilinguals. He suggested that there will be a developmental advantage when children are exposed to a second language earlier. Yip (2013) challenged this by noting that "there will necessarily be developmental differences" between children exposed from birth and those who are exposed between ages two and three, and de Houwer (1995) argued that age three may be too late to find out early differences. Consequently, Padilla and Lindholm (1984) and de Houwer (2009) defined simultaneous bilinguals as who are exposed to a second language from birth, a view which was also supported by Paradis et al. (2004). Similarly, Kim et al. (2018) defined simultaneous bilinguals as those who are exposed to both languages from birth and successive bilinguals as those introduced to a second language later within the first three years of life.

While much of the existing research on bilingual speech acquisition has concentrated on well-studied language pairs like Spanish-English, there is a significant lack of data on simultaneous bilingualism involving Indian languages. In India, a country rich in linguistic diversity, bilingualism and multilingualism are more common than not. Even though the 2011 census reports 26.02% of the Indian population to be bilingual, Nagarajan (2018) reported that 52% of the urban youth are bilingual, with an additional 18% speaking three or more languages, suggesting a substantially higher prevalence of bilingualism in urbanised settings than the national average indicates. Urban-rural discrepancy in bilingualism was consistently confirmed by longitudinal census analyses. Mallikarjun (2019) reported that multilingualism among Indian language speakers increased from about 10% in the 1961 to over 33% by the early 21st century census, which may have been due to urbanisation, migration, English-medium education, and socioeconomic demands. These rapid generational changes created increasingly

multilingual language environments for children at a young age. However, since there is a lack of accurate normative data, the difficulty for speech-language pathologists to differentiate typical multilingual or bilingual development from speech sound disorders increases.

Kannada, a Dravidian language, and English, a Germanic language, have distinct phonological systems. Kannada's phonology includes a series of retroflex consonants, a strong contrast between long and short vowels, and specific syllable structures that differ significantly from those in English (Wiltshire, 2015). Conversely, English features sounds and clusters absent in Kannada, such as the dental fricatives /θ/ and /ð/, and complex consonant clusters (e.g., /skr/, /spl/). The interaction between these two systems during the simultaneous acquisition period presents a fascinating area of study. Earlier studies on other Dravidian-English bilinguals indicate that phonological transfer, where sounds or patterns from one language influence production in the other, is a common occurrence (Fabiano-Smith & Goldstein, 2010). For instance, a child might use a retroflex consonant from Kannada when producing an alveolar sound in English or simplify an English consonant cluster by inserting a vowel, a common phonotactic process in Kannada. The age range of 4 to 5 years is a critical period for speech sound development in both monolingual and bilingual children. By age 4, English monolingual children typically acquire most speech sounds, although some, like /r/, /l/, and /θ/ sounds, may still be developing (Gillette Children's, n.d., as cited in Valliappan et al., 2023). Similarly, studies in other Indian languages indicate that most sounds are acquired by this age, but some complex sounds or clusters may still be emerging (IOSR Journal, n.d., as cited in Valliappan et al., 2023).

According to Sridhar (1990), Kannada has a complex consonant system with four-way stop contrasts and dental–retroflex distinctions. Early acquired consonants include stops (/p/, /b/, /t/, /d/, /k/, and /g/), nasals (/m/ and /n/), and glides (/j/ and /w/), whereas fricatives (/s/ and /ʃ/), affricates (/ʧ/ and /ʤ/), and retroflex sounds (/ʈ/, /ɖ/, /ɳ/ and / ɭ/) are acquired later

(Prathima, 2009; Shetty, 2015). Kannada vowels include five short vowels, such as /i/, /e/, /u/, /o/, and /a/ and five corresponding long vowels, such as /iː/, /eː/, /uː/, /oː/, and /aː/, with vowel length functioning phonemically (Caroline Wiltshire, 2015). Long vowels and diphthongs such as /ai/ and /au/ may continue to stabilise until the age of 5 years, particularly in bilingual children (Margaret Kehoe, 2002).

Divyashree and Sreedevi (2018) found acquisition sequences of initial and medial consonant clusters grouped based on sound class for 90% acquisition in Kannada speaking typical children across age groups. Initial clusters were /pl/ at >4;0 to ≤ 4;6 years, and /skr/, /spr/, /skv/, /gr/, /dr/, and /kr/ at 4;6 to ≤ 5;0 years, and medial clusters tested were /ɖl/, /dr/, /sʈ/, /rd/, /rt/, etc. achieved at >4;0 to ≤ 4;6 years and /dj/, /sr/, /kr/, /gr/, etc. at 4;6 to ≤ 5;0 years. Most of the consonant clusters were acquired by the age of 5.6 years, except for three clusters (/sv/, /dr/, and /ʈr/). A comprehensive analysis of the phonetic inventory and phonological processes of Kannada-English bilingual children in this age group will provide invaluable normative data. This research is not only academically significant but also has direct clinical implications, as it will equip clinicians with the necessary knowledge to make informed decisions and provide culturally and linguistically appropriate assessments and interventions for this underserved population.

Need of the study

As global connections continue to grow, understanding bilingual language acquisition has become increasingly important (Fabiano-Smith & Barlow, 2009). While significant research already exists on monolingual children and certain bilingual groups on speech sound development, such as Spanish-English (Fabiano-Smith et al., 2021; Montanari et al., 2018; Gildersleeve-Neumann et al., 2008), there remains a noticeable deficit in information on the phonological development of Kannada English simultaneous bilingual children. This gap is important to be addressed for simultaneous bilinguals, who acquire both L1 and L2 languages

from birth, compared to sequential bilinguals who learn a second language, L2, after establishing their first, L1 (Lin et al., 2023).

There is a lack of research that is evident, especially in the developmental trajectories of speech sounds in the 4 to 5-year-old age group. This interval represents a crucial phase for the differentiation and stabilisation of the phonological system in typically developing children (Lee, 2020). It is also the age at which there is the expected completion of phonological development. The phonological development of bilingual children may diverge from monolingual norms due to the interaction between two evolving sound systems (Ruiz-Felter et al., 2016; Fabiano-Smith et al., 2021). Developing appropriate developmental norms for Kannada-English bilinguals is therefore crucial as current data are inadequate.

Since there is an absence of normative data for Kannada-English bilinguals, it creates substantial challenges for clinical practice. Without any appropriate benchmarks linguistically and culturally, clinicians may risk the chances of misdiagnosing typical bilingual variations as speech disorders or delays. They may even fail in identifying impairments (Kan et al., 2021). McLeod and Verdon (2017) explained that these gaps interfere with accurate assessment and intervention for the bilingual population. Hence, the study's need lies in providing preliminary normative data on speech sound development in Kannada-English simultaneous bilingual children aged 4 to 5 years. Addressing this rift will not only help in advancing academic knowledge but also supports evidence-based clinical practices, assuring appropriate diagnosis and interventions that are responsive culturally for this in-need population.

Aim of the study

The aim of the study is to investigate the Speech sound development of typically developing Kannada-English simultaneous bilingual children in the age range of 4 to 5 years.

Objective of the study

1. To investigate the Speech sound development pattern in L1 (Kannada) and L2 (English) of typically developing Kannada-English simultaneous bilingual children.
2. To investigate the speech sound accuracy of L1 (Kannada) and L2 (English) in typically developing Kannada-English simultaneous bilingual children based on the following four articulatory outcome measures
    - Consonant – Vowel (CV) Accuracy
    - Whole word accuracy measures and proportion of whole-word correctness
    - Percentage of consonants correct (PCC-R)
    - Percentage of speech intelligibility
3. To compare the above-mentioned articulatory outcome measures between L1 and L2 of the participants within the age group.
4. To compare the above-mentioned articulatory outcome measures between age groups for both L1 and L2.

Chapter II

REVIEW OF LITERATURE

Speech sound acquisition is a process that involves a complex interplay of both biological predispositions and environmental interactions. It enables infants to develop from a limited vocal repertoire to a sophisticated command of their phonology, which is native to them (Ekström, 2022). This developmental trajectory requires the complex coordination of articulatory structures, including the jaw, lips, and tongue, along with the maturation of neuromotor control (Namasivayam et al., 2025). This maturation process significantly influences the emerging phonological system often leading to predictable biases in early speech due to constraints on oromotor coordination (Green et al., 2000). The refinement of speech motor control involves a transition from generalised movement to a highly specific muscular coordination for speech production which is a process distinct from other oral motor activities like sucking and chewing (Fernandes, 2017).

Anatomical changes and developments of the vocal tract as well as advancements in motor control are significant in reaching the adult benchmark for the production of speech. This shows the close interaction that exists between anatomical changes and motor control in the speech production mechanism. The process of acquiring the sound system of a first language entails more than the learning of particular sounds; it also includes the learning of the distribution of sounds, combination of sounds, and prosody aspects such as syllable stress and rhythm (Curtin & Zamuner, 2014). In addition, the process of sound system acquisition is also influenced by the lexical environment in which the child grows up, with lexical statistics significantly affecting how the sound system is developed (Li & Munson, 2016).This continuous adaptation and refinement suggest that speech sound acquisition is a dynamic, goal-directed process that integrates lexical, phonological, and motor development (Noiray et al., 2019).

Learning speech sounds is an extremely complicated procedure necessary for the adequate development of linguistic skills, which is governed by the interaction of universal principles of phonetics and specific phonology of different languages (Grech, 2000). Such interplay makes it necessary to conduct a comparative study of the phenomenon, especially contrasting Western studies on speech sound acquisition with the data available from Indian languages that have rather complicated phonological structure (Maphalala et al., 2014). Speech sound development among Western speakers was widely studied and numerous research projects were dedicated to consonant and vowel learning as well as phonological processes that included the use of standardized tests of single words (SSTP, 2022). However, when it comes to the study of the development of speech sounds in Indian languages, there arise difficulties associated with the construction of reliable native language-based testing instruments since translation of standardized tests may be inaccurate (Prusty et al., 2022). Moreover, the complex phonotactic rules found in several Indian languages, which determine the sound combinations in words, pose special developmental problems that require special techniques for analysis (Ranjitha & Sreedevi, 2024).

Bansal and Kumaraswamy (2023) have found that vowel acquisition in Hindi can sometimes be different from what is generally known in Western languages. Such differences have also been recorded in the acquisition of consonants and phonological processes, meaning there is a need to find out more on how this process takes place in languages that have complex consonant and syllable structures (McLeod & Crowe, 2018). This is evidenced in cases of studies carried out among Korean speakers who learn English as a foreign language where it is possible to find out how native language knowledge affects speech qualities, thus impacting the learning process of new phonological patterns (Kim & Ha, 2023). In fact, when there is heritage language use in second language acquisition, as is evident when learning Konkani language among speakers of Malayalam language, native language knowledge significantly

impacts second language acquisition (Clausen et al., 2022; Mayr et al., 2021). This highlights the dynamic interaction between physiological and perceptual limitations as well as statistics of the lexicon in a particular language in the process of phonological development (Edwards & Beckman, 2008).

2.1. Factors affecting speech acquisition

Speech acquisition depends on person-to-person, based on multiple factors. Some of the factors are:

2.1.1. Biological and Individual Factors

Biological maturation is a primary driver of speech development. As children grow, their articulatory control improves, allowing for the production of more complex sounds.

Age and Maturation

According to the phonological developmental norms, by ages 4 to 5, most children tend to have acquired a considerable number of the phonetics of their language. Bansal & Kumaraswamy found that vowels are mastered by age 4, but specific phonemes such as medial /ɔ:/ not be mastered by age 5. In multilingual Indian children, singleton consonants are mastered by age 4;6 (Lim & Chieng, 2021).

Gender

Although a few studies indicate that girls might have an advantage over boys in mastering sound in their early stages of development (Kehoe & Girardier, 2020; Kehoe & Havy, 2018), other studies conducted in India did not report any influence of gender on speech acquisition in English-Malay language among Indian children (Lim & Chieng, 2021).

Oral Motor and Perceptual Skills

Articulator coordination skills are extremely essential. The fricatives are usually learned late in comparison to the stops because of the need for a higher degree of articulation

skills (Grandon, 2016). In addition, children who perform well in terms of perceiving speech sounds have higher speech production accuracy skills (Munson et al., 2011).

2.1.2. Cognitive-Linguistic Factors

Internal cognitive processes play a significant role in how children organize and produce speech sounds.

Phonological Awareness

Children who have stronger phonological awareness tend to acquire and produce speech sounds more accurately because conscious sensitivity to syllables, onsets, rimes, and phonemes supports fine-grained mapping between heard sounds and articulatory targets (Chung et al., 2019; Hancock et al., 2017)

Phonological memory (verbal short-term memory)

Better phonological memory supports holding novel sound sequences long enough to form stable motor plans and phonological representations, so deficits here are linked to inconsistent or delayed sound production (Schussler, 2012).

Vocabulary Size

There is a known correlation between lexical development and phonological growth. A larger total vocabulary in bilingual children is often associated with better accuracy in consonants and clusters (Kehoe & Girardier, 2020; Kehoe & Havy, 2018).

Attention and executive control

Sustained attention and monitoring let children notice mismatches between intended and produced sounds and self-correct. Poor attention/executive control increases persistence of error patterns and reduces learning from feedback (Nip et al., 2011).

2.1.3. Environmental and Socio-Economic Factors

The quality and quantity of language exposure significantly impact Speech sound acquisition.

Socioeconomic status

Higher socio-economic status correlate with greater phonological achievement like in terms of higher percentages of correct consonant production (Kehoe & Girardier, 2020; Kehoe & Havy, 2018). In India, studies conducted with Kannada speaking children found marked disparities in semantic language tests among children with different socio-economic status, especially around three years of age (Dadlani et al., 2018).

Input Quality

Exposure to "infant-directed speech" (higher pitch, simpler syntax, and hyperarticulated sounds) helps infants and toddlers establish clear phonological representations, which serve as the foundation for later production (Munson et al., 2011).

Cultural and Educational Changes

Shifts in social and educational environments in India have been noted to potentially delay certain acquisition patterns in languages like Hindi compared to older norms (Bansal & Kumaraswamy, 2023).

2.1.4. Factors Specific to Bilingualism in Indian Context

For simultaneous bilingual Indian children, the interaction between two (or more) languages is a critical factor.

Cross-Linguistic Influence

Bilingual children may experience "transfer" where the phonological rules of one language affect the other. This can be positive (acceleration) or negative (deceleration) (Hambly et al., 2012; Scarpelli & Core, 2015). For instance, exposure to Tamil, which shares certain consonant clusters with English, has been found to accelerate the acquisition of English clusters in bilingual children (Lim & Chieng, 2021).

Language Dominance and Exposure

The percentage of exposure to each language is a strong predictor of accuracy in those specific languages. Higher exposure typically leads to higher PCC and fewer error patterns in that language (Kehoe & Girardier, 2020; Lim & Chieng, 2021).

Typological Complexity

The frequency and complexity of specific sounds in a child's languages influence acquisition. Indian languages often feature retroflex sounds, which can be among the more challenging sounds to master, even for children with typical development (Bathina et al., 2022).

Multilingual Environments

Many Indian children live in environments where they are exposed to three or more languages and this "multilingual effect" can lead to different error patterns compared to monolingual peers such as specific patterns of cluster reduction or substitution (Chervela, 1981; Lim & Chieng, 2021).

Global Milestones in Speech Sound Acquisition

While the exact timing varies by language, a general sequence of mastery is observable in children around the world:

Early Mastery (by approximately 4 years)

Children typically master plosives (e.g., /p/, /b/, /t/, /d/, /k/, /g/), nasals (/m, n/), and glides (/w/, /j/) relatively early (Crowe & McLeod, 2020; McAlister et al., 2022; Tresoldi et al., 2018). For instance, in Italian and English, voiceless plosives like /p/, /t/ and nasals like /m/, /n/ are often mastered by age 3 (Tresoldi et al., 2018).

Intermediate Mastery (4 to 5 years)

Affricates (e.g., /tʃ, dʒ/) and certain fricatives (/f, s/) generally reach mastery during this period (Crowe & McLeod, 2020).

Late Mastery (5+ years)

Liquids (/l/, /r/) and complex fricatives (e.g., /v/, /z/, /θ/, /ð/) are often the last to be mastered (Crowe & McLeod, 2020). In Fiji English, r-clusters may not be fully acquired until age 9;6 (McAlister et al., 2022).

Linguistic environment significantly affects these timelines. For instance, Danish children often resolve typical phonological patterns between ages 3;6 and 4;6, whereas Norwegian children may not do so until after the age of 5 (Fox-Boyer et al., 2021).

2.2. Bilingualism

Bilingualism, especially in the Indian scenario, is a complex process where the child acquires two or more languages at the very time of birth or infancy itself. Simultaneous bilinguals are those who learn two languages from birth or before the age of three (Scarpelli & Core, 2015). The simultaneous learning process involves exposure to two phonology systems simultaneously. There are certain differences between the development of children who speak two languages simultaneously and those who do not. The idea of bilingualism may be explained in various models.

2.2.1. Models of bilingualism

The study of bilingualism also includes well-established theoretical models to explain how two languages will interact, especially in speech sound acquisition and phonology. And these models are valued for their strong empirical basis and predictive power across the lifespan. Some of the models are:

a) The Speech Learning Model (SLM/SLM-r)

Flege (1995) suggests that bilingual individuals maintain phonetic contrasts between languages within a shared phonological system. Here, the 2nd language, L2 sound are identified as identical, similar, or new, and it predicted that “similar” sounds are the

most difficult to acquire, while the revised version emphasizes lifelong phonetic reorganization based on input.

b) The Perceptual Assimilation Model (PAM-L2)

Best and Tyler (2007) explains 2nd language (L2) perception as the mapping of non-native sounds onto existing 1st language (L1) categories, which results in varying levels of discrimination difficulty depending on how sounds are assimilated.

c) The Second Language Linguistic Perception (L2LP) model

Escudero in 2005 proposed that learners initially transfer their entire L1 perceptual system to the L2 and gradually restructure it with increased exposure, effectively predicting developmental patterns in both sequential and simultaneous bilinguals.

Theoretical Frameworks in Bilingual Acquisition

Research into bilingual speech sound acquisition often focuses on how the two linguistic systems interact. There are three primary outcomes of this interaction:

Deceleration

The child's phonological development in one or both languages may be slower than that of monolingual children (Hambly et al., 2012; Scarpelli & Core, 2015).

Acceleration

Exposure to two languages may speed up the acquisition of certain sounds or structures. For example, bilingual children of Indian heritage acquiring English and Malay have shown accelerated acquisition of consonant clusters, likely due to the presence of similar structures across their languages (Lim & Chieng, 2021).

Transfer

Phonological rules or features from one language are applied to the other. This cross-linguistic influence can result in error patterns that are unique to bilinguals and are not typically

seen in monolingual development (Hambly et al., 2012; Scarpelli & Core, 2015).

Key Influencers of Bilingual Speech Development

The proficiency and accuracy of a bilingual child's speech are heavily dependent on several internal and external factors:

Language Exposure and Dominance

The amount of daily exposure to each language is one of the strongest predictors of speech sound accuracy. Children generally show higher percentage of consonants correct (PCC-R) in the language they are more frequently exposed to (Kehoe & Girardier, 2020; Lim & Chieng, 2021).

Lexical Development

There is a significant correlation between a child's vocabulary size and their phonological accuracy. Bilingual children with larger total vocabularies across both languages often demonstrate better performance in consonant and cluster production (Kehoe & Girardier, 2020; Kehoe & Havy, 2018).

Phonological Typology

The structural similarities or differences between the languages play a role. Indian languages, for instance, frequently utilize retroflex consonants and specific medial clusters, which can influence how children acquire sounds in a second language like English (Bathina et al., 2022; Chervela, 1981).

Types of bilinguals

According to Thirumalai and Shyamala (1986), there are five classification systems for bilingualism.

A. Balanced and dominant bilinguals

These terms were proposed to understand the level of proficiency, or the degree of bilingualism. Lambert (1978) suggests the term balanced bilingual for a speaker who shows

equal proficiency in all domains of speech, in both L1 and L2, and for speakers who are dominant in one language, but not the other, the term dominant bilingual was used. The less dominant language is called the subordinate language.

B. Compound and coordinate bilinguals

Based on their patterns of language use and function, Ervin and Osgood (1954) suggest two types of bilinguals: compound and coordinate. Their definitions are inspired by Weinreich's (1968) concept of compound, coordinate and subordinate bilinguals. Weinreich's typology of bilingual description is based on the understanding at that time of how the two languages are mapped in the brain. Ervin and Osgood, however, were concerned with how these different types of bilinguals come into being based on their language use. Ervin and Osgood merged Weinreich's concept of compound and subordinate bilinguals and called it 'compound'. According to them compound bilinguals develop through their experience of using the two languages simultaneously in various domains whereas coordinate bilinguals use one language in one domain and the other language in another domain (for instance Language A at home and Language B at work).

C. Natural bilinguals and structure bilinguals

Based on the method of acquisition a distinction is made between natural bilinguals and structure bilinguals. Skutnabb-Kangas (1981) refer to the term natural bilingualism for speakers who acquire both languages in a natural setting and not with structured instructions. On the other hand, structure bilingualism is where a language is acquired in a structured environment like a school or from a tutor. It is possible that the natural bilinguals acquire one language in one domain and another language in another domain. This is common with children of migrant populations who speak one language at home and another outside the home.

D. Simultaneous bilinguals and consecutive or successive or sequential bilinguals

Another distinction made is on the basis of the age of acquisition. Children who acquire two languages as 'first languages' or L1s are called simultaneous bilinguals (Hamer & Blanc 2000; Lyon 1996). This is also called "bilingual first language acquisition" (Meisel, 1989; de Houwer, 1995) or early bilinguals. On the other hand, children who are exposed to one language at home until the age of three and come into contact with another language later from their neighbourhood, larger community or school after the age of three are called consecutive or successive. The defining factor of consecutive or successive bilinguals is that they are speakers who acquire another language after already knowing a language (Hamer & Blanc 2000; Lyon 1996). This is also called "bilingual second language acquisition" (Meisel 1989; de Houwer 1995). There is no upper age limit for bilingual second language acquisition (Meisel 1989, de Houwer 1995). Such bilinguals are sometimes broadly called late bilinguals as well.

The Indian Multilingual Context

In India, multilingualism is often the norm rather than the exception. Children in these environments frequently move between a regional mother tongue (e.g., Tamil, Hindi, or Telugu) and a lingua franca like English or another regional language (Bansal & Kumaraswamy, 2023; Lim & Chieng, 2021). Research indicates that children may master certain phonetic inventories, such as vowels and singleton consonants, by age 4 to 5, though more complex structures like retroflexes or specific medial clusters may continue to develop (Bansal & Kumaraswamy, 2023; Chervela, 1981). Children are exposed to different languages as they converse in their mother tongue at home or neighbourhood and other languages at school, peer group, or friend circle. This exposure is mainly seen in urban areas of India where people from different regions meet on a daily basis.

2.3. Speech sound acquisition in monolinguals and bilinguals

The development of speech sound acquisition globally demonstrates a combination of universal milestones and language-specific trajectories. Research across 27 different languages indicates that by age 5, most typically developing children have acquired the majority of their native phonetic inventory (Crowe & McLeod, 2020; Haaften et al., 2020). There are several Western as well as Indian studies on monolingual and bilingual speech sound acquisition. Emphasis should be given to both groups for better understanding and comparing the differences.

2.3.1. Speech sound acquisition in monolinguals

Stoel-Gammon (1985) found that children between the age of 9 to 24 months develops speech sounds gradually, with voiced stops, nasals, and glides appearing in initial position by the age of 15 months and more complex sounds like voiceless stops, velars, and some fricatives emerging by 24 months. It was also noted that in a study by Fudala and Reynolds (1986), they reported acquisition of /s/ and /z/ being relatively late, which was around 6 to 11 years, with fluctuating accuracy, and Templin (1957) showed that most initial consonant clusters are mastered by the age of 4, whereas more complex clusters continue developing until about 8 years. Table 2.1 maps out different studies on Speech sound acquisition in English.

Table 2.1

Comparison of studies on Speech sound acquisition in English from earlier studies

Speech Sound	Wellman (1931) 75%	Poole (1934) 100%	Templin (1957) 75%	Sander (1972) 75%	Prather (1975) 75%	Arlt (1976) 75%	Fudala (1986) 90%
m	3	3.5	3	<2	2	3	2
n	3	4.5	3	<2	2	3	2
h	3	3.5	3	<2	2	3	1.5
p	4	3.5	3	<2	2	3	2 to 3
f	3	5.5	3	3	2 to 4	3	2.5 to 3
w	3	3.5	3	<2	2 to 8	3	1.5
b	3	3.5	4	<2	2 to 8	3	2 to 3
ŋ	_	4.5	3	2	2	3	3

j	4	4.5	3.5	3	2 to 4	_	3
k	4	4.5	4	2	2 to 4	3	2.5 to 3
g	4	4.5	4	2	2 to 4	3	2.5 to 3
l	4	6.5	6	3	3 to 4	4	5
d	5	4.5	4	2	2 to 4	3	2.5
t	5	4.5	6	2	2 to 8	3	3 to 4
s	5	7.5	4.5	3	3	4	11
r	5	7.5	4	3	3 to 4	5	5.5
tʃ	5	_	4.5	4	3 to 8	4	5.5
v	5	6.5	6	4	4	3.5	5.5
z	5	7.5	7	4	4	4	11
ʒ	6	6.5	7	6	4	4	_
θ	_	7.5	6	5	4	5	6
dʒ	_	_	7	4	4	4	5
ʃ	_	6.5	4.5	4	3 to 8	4.5	5.5

Note. Adapted from Prathima & Sreedevi (2009), *Articulation Acquisition in Kannada Speaking Urban Children: 3-4 Years.*

Pyata and Banik (2016), examined phonological development in typically developing Hindi speaking children aged 2.5 to 6.5 years, and it was found that most of the stop consonants such as /p/, /b/, /t̪/, /d̪/, /t/, /k/, and /g/ were acquired across all word positions by 3.5 years in 80 to 100% of children, while /d/ reached similar proficiency by 4.5 years. Fricatives such as /f/, /s/, /h/, and /v/ were mastered in all positions by 3.5 years in at least 80% of children. Among affricates, /dʒ/ was acquired across all positions by the age of 3.5 years, whereas /tʃ/ was acquired initially by 3.5 years and in medial and final positions by 4.5 years. Aspirated consonants like /bʰ/, /kʰ/, /gʰ/, /tʰ/, /dʰ/, /dʒʰ/ were generally acquired in all positions by 3.5 years, while /ʃ/ emerged by the age of 4.5 years. The affricate /tʃʰ/ showed a delayed pattern, where by 3.5 years it was acquired in the initial position, by 4.5 years in the final position, and by 5.5 years in the medial position. Dental aspirates, /t̪ʰ/, and /d̪ʰ/were acquired by 4.5 years in at least 80% of children.

Similarly, Roshini et al. (2025) gave attention to phonetic repertoire and syllable structure types used by Tamil-speaking children with and without language delay. The presence of retroflex consonants, geminate clusters and semi-vowels amongst consonants and increased

production of mid vowels were observed amongst Tamil-speaking children around two years of age. These findings highlight the influence of ambient language (Tamil) on the pattern of speech sound acquisition. Table 2.2 compares the percentage of children with different consonants in their inventory amongst late talkers (LTs) and typically developing (TD) children.

Table 2.2

Percentage of Children Producing Speech Sounds in LTs and TD Children according to Roshini et al. (2025)

Percentage of Children (%)	LTs	TD Children
> 90	/m/, /p/	/p/, /b/, /t/, /d/, /k/, /m/, /oʊ/, /d/, /n/
75–90	_	/g/, /l/
50–75	/t/, /k/, /b/, /tʃ/	/s/, /tʃ/, /h/, /ŋ/, /j/
< 50	/d/, /n/, /j/, /h/, /v/, /dʒ/, /g/, /ŋ/, /tʃ/, /s/	/f/, /dʒ/, /ʃ/, /ŋ/, /r/

Note. LTs = Late Talkers; TD = Typically Developing children.

Prathima and Sreedevi (2009) examined speech sound acquisition in Kannada-speaking children aged 3 to 4 years, considering place, manner, and voicing features. Most unaspirated consonants across bilabial, labiodental, palatal, dental, velar, and retroflex places were acquired by 3.0 to 3.6 years, while /h/ and /r/ were mastered later due to much greater articulatory complexity. Voiced sounds were generally acquired by 3.6 to 4.0 years. Vowels, nasals, diphthongs, and plosives emerged early, whereas trills showed the most delay. Recent clinical observations indicate that most Kannada singleton consonants are mastered by the age of 3 to 4 years.

Deepa and Savithri (2010) studied the speech sound acquisition in 2 to 6 year-old native Kannada speaking children. All the vowels and diphthongs were found to have acquired by the age of 2 years by 90% of the children. Most of the consonants were acquired by the age of 2.6 years; except /tʃ/, /dʒ/, /t̪/, /d̪/, /ŋ/, /r/, /l/, /ʃ/, /s/, /h/, /ɭ/ and clusters.

Table 2.3

Comparison of earlier studies on Speech sound acquisition in Indian Languages

Speech Sound	Tasneem Banu (1977) Kannada 75%	Usha (1986) Tamil 75%	Padmaja (1988) Telugu 75%	Arun Banik (1988) Bengali 90%	Maya (1990) Malayalam 75%	Prathima (2009) Kannada 90%	Divya (2010) Malayalam 75%	90%	Deepa (2010) Kannada 100%	Neenu (2011) Malayalam 100%
m	3	3	2.6	2.5	3–3.6	3–3.6	2–2.3	2–2.3	3–3.3	2
n	3	3	2.6	2.5	3–3.6	3–3.6	2–2.3	2–2.3	3–3.3	2
ŋ	_	_	_	2.5	3–3.6	_	2–2.3	2–2.3	3.4–3.6	4.6
p	3	3	2.6	2.5	3–3.6	3–3.6	2–2.3	2–2.3	3–3.3	2
f	_	_	2.9	_	3–3.6	_	–	–	3.4–3.6	–
h	_	_	2.6	3	3–3.6	_	–	–	–	Above 6
k	3	3	2.6	2.7	3–3.6	3–3.6	2–2.3	2.3–2.6	3–3.3	2
b	3	3	2.6	2.5	3–3.6	3–3.6	2–2.3	2–2.3	3–3.3	2
d	3.6	3	2.6	3	3–3.6	3–3.6	2–2.3	2.3–2.3	3.4–3.6	3.6
g	3	3	2.6	3	3–3.6	3–3.6	2.3–2.6	2.6–2.9	3.4–3.6	2
r	4.6	_	3.9	4	3.7–4	_	2.6–2.9	–	–	5
s	3	3	3.3	_	3.6–4	3–3.6	–	–	–	4.6
ʃ	5.1	6	3.6	3	5–5.6	3.6–4	–	–	–	4
tʃ	3.7	3	2.6	3	3–3.6	3–3.6	–	–	–	3.6
dʒ							2–2.3	2–2.3	–	_
t	_	3	2.6	3	3–3.6	3–3.6	2–2.3	2.3–2.6	3.4–3.6	3.6
v	_	3	2.6	_	3–3.6	3–3.6	2.3–2.6	2.6–2.9	3.4–3.6	2.6
l	3	3	2.6	3	3–3.6	3–3.6	–	–	3.4–3.6	3
t̪h	_	_	_	3	6–6.6	_	_	_	_	
zʱ	_	_	_	4	_	_				2
j	3	3	2.6	3	3–3.6	3–3.6	2–2.3	2.3–2.6	3–3.3	_

2.3.2. Speech sound acquisition in bilinguals:

Bilingual phonological acquisition involves mastering the sound systems and production patterns of two languages. Although overall development is comparable to monolinguals (Junker & Stockman, 2002; Pearson et al., 1997), language-specific acquisition patterns may remain less clear. Early bilinguals produce shared, cross-linguistic sounds but often do not yet differentiate phonetic contrasts or phonotactic complexity (Redlinger & Park, 1979; Schnitzer & Krasinski, 1996; Volterra & Taeschner, 1977). Language-specific influences are evident, such as typical Spanish vowel development, but delayed German contrasts in Spanish–German bilinguals (Kehoe, 2002), and cross-linguistic facilitation of complex structures (Kehoe & Lleó, 2003). While sound inventories are broadly similar to those of monolinguals. Bilinguals may show cross-linguistic error patterns (Holm & Dodd, 1999; Keshavarz & Ingram, 2002; Anderson, 2004) and somewhat slower or variable development, and accuracy improves with age across groups.

Analyses of Indian Tamil heritage bilinguals indicate that all singleton consonants reach mastery by the age of 4.6 years, whereas the vowels will be fully acquired by 2.11 years. The shared clusters, such as those involving Tamil-English overlap, may emerge earlier than in monolingual peers due to ambient phonological facilitation (Lim & Chieng, 2021). Further analyses of Hindi-speaking Indian cohorts demonstrate that vowels and most singleton consonants typically reach mastery by 5.6 years while clusters continue developing through 6.6 years, thereby furnishing essential clinical benchmarks that differentiate typical bilingual trajectories from those affected by dominance variations (Bailoor et al., 2014; Rhydhm et al., 2019).

A study on 3-4-year-old sequential Kannada-English bilingual children by Bailoor and Krishnan (2014) revealed the occurrence of a total of 14 phonological processes. The most common processes occurring were fronting, cluster reduction, Epenthesis, initial consonant

deletion, affrication, metathesis and final consonant deletion. The least occurring was medial consonant deletion, backing of stops, alveolar assimilation, stopping and backing of fricatives, and vowel un-rounding. Medial consonant deletion, stopping and alveolar assimilation were the unique processes found only in one subject each. Further, the results of this study were compared with findings on Tulu-Kannada bilinguals (Mala, 2001) and Kannada monolingual speaking children (Sunil, 1995) of the same age group. The results revealed that there was a significant difference in Kannada-English bilinguals and Tulu-Kannada bilinguals for fronting, cluster reduction, affrication, medial consonant deletion and epenthesis. On comparing Kannada-English bilinguals and Kannada monolinguals, there was a significant difference seen in fronting, cluster reduction and final consonant deletion.

Speech Sound Acquisition in Multilingual and Indian Contexts

For simultaneous bilingual children, the interaction between their languages creates unique developmental patterns. In multilingual settings, children often show high levels of accuracy in consonants and vowels, though performance can vary based on language dominance and the specific sound categories (Mayr et al., 2021).

Shared vs. Language-Specific Sounds

Bilingual children tend to perform better on sounds shared between their two languages than on language-specific sounds (Mayr et al., 2021). In Fiji English (including Fiji Hindi dialects), sounds common to both English and the local languages are acquired earlier than English-specific sounds (McAlister et al., 2022).

Bilingual Indian Heritage

A study of English-Malay bilingual children of Indian heritage found that all vowels were acquired by age 2;11, and all singleton consonants were mastered by 4;06 (Lim & Chieng, 2021).

2.4. Comparison between English and Kannada Phonology

Phonology refers to the sound system of a language. It includes the classification, organisation, production, and perception of speech sounds (Vihman, 1996), and is comprised of two key components: a finite set of phonemes which is categorised by acoustic properties, physiological properties, and phonotactic rules that govern their acceptable combinations (Hodson & Paden, 1981). Phonological development occurs gradually as children expand their vocabulary, progressing from a simple to a more complex sound pattern. During this process, children may exhibit systematic and predictable patterns of substitutions as well as omissions. This reflects an organised approach to managing speech production constraints (Markman, Wasow & Hansen, 2003).

The phonological system of English and Kannada may differ and hence a need for comparing the phonology of English and Kannada, two languages from distinct families such as Germanic and Dravidian, respectively, is there, to portray their divergent phonotactic constraints, phonetic inventories, and prosodic features. Elaboration of articulatory investigations of coronal contrasts and affricates in Kannada (Kochetov et al., 2020, 2023; Kochetov & Sreedevi, 2015), along with established phonological classification of Germanic and Dravidian languages (Schmid, 2012), will be highlighted to explain the typological divergences in sound patterns from different ancestries. Specifically, while English phonology permits complex consonant clusters and stress patterns shaped by lexical and morphological cues, Kannada exhibits a robust set of coronal phonemic contrasts, including dentals and retroflexes, occurring with various manners of articulation (Kochetov et al., 2020). Kannada also demonstrates complex articulatory patterns, such as the production of the geminate alveolopalatal affricate /ʧ/ with a tongue shape intermediate between a palatal glide and a dental stop, distinguishing it from English affricates (Kochetov & Sreedevi, 2015).

The detailed articulatory analysis, encompassing both qualitative and quantitative approaches, underscores fundamental differences in phoneme classification and articulatory mechanisms between the two languages (Kochetov et al., 2023; Pham & Hai, 2025). Such cross-linguistic phonetic and phonological variations present significant challenges in second language acquisition, where the native phoneme system often influences the perception and production of target language sounds (Duyen, 2024; Kamsinah & Natsir, 2025). This necessitates a thorough contrastive analysis to identify specific areas of phonological interference, a common hurdle in interlanguage development (Bohara & Paneru, 2024). Therefore, there is a need to systematically compare the phonological systems of English and Kannada, focusing on segmental inventories, supra-segmental features, and phonotactic structures, to provide a comprehensive understanding of their differences and similarities.

Previous scholarly work has frequently highlighted that there are significant distinctions between Indo-European and Dravidian language families' phonology, which can impact both second language acquisition and cross-linguistic intelligibility (Addow et al., 2025; Andi-Pallawa & Alam, 2013). For instance, English and Indonesian, though both using the Latin alphabet, exhibit notable differences in their phoneme systems, with English possessing a wider array of vowel phonemes and more intricate pronunciation patterns (Fitria, 2024).

Crowe and McLeod (2020) revealed that, children acquiring English in the United States typically master most consonants by age 5, with plosives, nasals, and glides acquiring earlier, followed by affricates, liquids, and finally the fricatives by around age of 6 to 7. Even though sounds like /r/ and /s/ show the greatest variability, they are often acquired late, which may reflect both developmental patterns and methodological differences across studies. Table 2.4 maps the speech sound acquisition in English across United States as well as across the globe.

Table 2.4

Speech Sound Acquisition in English across the United States and Global Samples by Age and Criterion based on Crowe and McLeod (2020)

	US Sample			Global Sample		
No. of studies/Age (months)	**50%**	**75%**	**90%**	**50%**	**75-85%**	**90-100%**
No. of studies at each criterion	8	9	10	5	9	8
24–35 months (2;0–2;11)	/p, b, t, d, k, g, m, n, ŋ, f, v, s, z, ʃ, h, j, l, w, tʃ, dʒ/	/p, b, t, d, k, g, m, n, f, h, w/	/p, b, d, m, n, h, w/	/p, b, d, t, k, g, m, n, f, s, ʃ, h, j, w/	/p, b, d, k, g, m, n, f, h, w/	/p/
36–47 months (3;0–3;11)	/θ, ð, ʒ/	/ŋ, v, s, z, ʃ, j, l, tʃ, dʒ/	/t, k, g, n, f, ʃ, j/	/v, z, ð, ʒ, m, l, tʃ, dʒ/	/t, s, ʃ, j, l/	/b, t, d, k, g, m, n, f, h, j, w/
48–59 months (4;0–4;11)	_	/θ, ð, w/	/v, s, z, ʃ, l, tʃ, dʒ/	/θ/	/v, z, ʒ, j, tʃ, dʒ/	/v, s, z, ʃ, l, tʃ, dʒ/
60–71 months (5;0–5;11)	_	/ð/	/ð, ʒ, j/	_	/ð/	/ð, ʒ, j/
72–83 months (6;0–6;11)	_	_	/θ/	_	/θ/	/θ/

Note. Adapted from Crowe, K., & McLeod, S. (2020). *Children's English consonant acquisition in the United States: A review*.

English contains multiple consonant clusters across positions. A study by Dyson (1998) mapped out the clusters in different positions across age by noting them. It was observed that English consonant clusters develop progressively during early childhood. Initial clusters such as /fw/ emerged around 2.0 years, followed by /br/ and /kw/ by 2.9 years, while more complex clusters including /tr/, /sp/, /st/, /sn/, and /sl/ were acquired by approximately 3.3 years. Final clusters such as /ts/ and /ŋk/ were observed to appear around 2.0 years, whereas /ps/, /nts/, and /nk/ were acquired between 2.5 and 3.3 years. Similar findings were reported by Wantson and Scukanec (1997) in 2 to 6-year-olds as well.

Kannada, being a Dravidian language, has its own diversity when compared to English. Speech sound acquisition in Kannada shows that most consonants are acquired by around the age of 3 years. Sounds such as /r/, /tʃ/, and /ʃ/ are acquired later. But more recent findings suggest earlier mastery of these sounds, especially /ʃ/ and /tʃ/, even when the criteria are stricter (Prathima & Sreedevi, 2009). Similarly, Sridhar (1990) described Kannada as a language having a rich consonantal system organised by place (labial, retroflex, dental, velar, and palatal) and manner of articulation. It includes voiceless/ unvoiced, voiced, aspirated, and breathy voiced stops across all major places of articulation, along with fricatives (/f/, /s/, /ʃ/, /h/, and /z/), nasals (/m/, /n/, and /ɳ/), laterals (/l/, and /ɭ/), a trill (/r/), and glides (/v/, and /j/).

A study in Kannada by Rupela and Manjula (2006) reported that there is early emergence of medial geminate clusters by 12 to 18 months, followed by medial non-geminate clusters by 18 to 24 months, while initial clusters stabilise later by 24 to 30 months. The final clusters are rare in Kannada, occurring mainly in borrowed English words. Prathima and Sreedevi (2009) found that among several clusters tested in 3 to 4-year-old children, only /ski/ and /kra/ were acquired by 90% of children by the age of four. Similarly, Deepa and Savithri (2010) showed that most clusters are acquired between 3;6 and 5;6 years, with some variation across gender and position, and certain clusters like /rtʃ/, remained unmastered even by 6 years of age. In a more recent study, Divyashree and Sreedevi (2018) found that simpler consonant clusters like initial /bl/, /kl/, /pl/, /sl/, and /st/ were seen to be acquired earlier, in contrast to more complex clusters such as /skr/, /spl/, /str/, /br/, /gr/, /dr/. After 5 years of age (5.0 to 6.0), more complex and later-developing clusters are mastered, including /str/, /tr/, /dr/, /sv/, /dv/, etc in initial position and clusters like /kt/, /ʈr/, and /ɻ r/ medially. It was observed that from a total of 49, 46 clusters reached 90% acquisition by the age of 5 years, and remaining 3 after the age of 5 years.

While comparing, it is understood that there is a need to study and understand speech sound acquisition in both languages of bilingual population, as the involvement of both languages may divert the normal phonological development in a child, especially when exposed early.

Research on Kannada phonology highlights its strong Dravidian roots, especially in its detailed system of coronal consonants (Kochetov et al., 2020, 2023). Kannada clearly distinguishes between dental and retroflex sounds across different manners of articulation, although these features are not widely documented in comparative phonetic studies (Kochetov et al., 2020). In contrast, English, which has Germanic origins, uses a simpler set of coronal sounds but includes fricative clusters (e.g., /t̪/, /ʃ/) that are often difficult for Kannada speakers because similar sounds are absent in Kannada (Craft, 2024; G & Jayanna, 2018). Differences are also seen in syllable structure. Kannada follows stricter phonotactic rules with simpler consonant patterns, while English allows complex consonant clusters. As a result, Kannada speakers often insert extra vowels (epenthesis) when pronouncing English cluster words (Kamsinah & Natsir, 2025; Pham & Hai, 2025).

There are also important differences in rhythm and stress. English relies on lexical stress to convey meaning, whereas Kannada is more syllable-timed and depends on pitch patterns rather than stress variation (Addow et al., 2025). Additionally, Kannada is an agglutinative language, meaning it uses multiple suffixes, making accurate pronunciation of the endings of a word important (Gunhal, 2025).

From an articulatory perspective, Kannada requires precise tongue placement, especially for dental and retroflex sounds, which differs from the more flexible articulation in English (Kochetov et al., 2020, 2023). These differences often lead to pronunciation substitutions. For example, the English sound /ð/ is often pronounced as /d/, and the distinction between /v/ and /w/ is often reduced to a single sound /ʋ/ (Craft, 2024).

To address these challenges, modern tools such as speech-to-text systems can provide better feedback by accounting for these phonological differences. Approaches like suffix-aware models and Akshara-based parsing (syllable-based units in Kannada) help analyze pronunciation more effectively (Gunhal, 2025). These methods also help differentiate between:

- Errors caused by first language (L1) influence (Kochetov et al., 2020, 2023)
- Errors that occur as part of natural language development (Ellis, 1996; Hecht & Mulford, 1982)

Advanced techniques such as cross-language model transfer and multi-task learning further improve speech analysis by focusing on detailed acoustic features rather than only full phoneme recognition (Arora et al., 2018).

It is understood that speech sound acquisition is influenced by biological, cognitive, environmental, and linguistic factors. Studies show that children acquire speech sounds gradually, with bilingual and multilingual children experiencing cross-linguistic influence based on language exposure and dominance. Research in Indian languages such as Kannada, Hindi, and Tamil highlights language-specific acquisition patterns that differ from English due to variations in phonology and phonotactics. The literature also emphasizes that English and Kannada differ in consonant systems, stress patterns, and syllable structures, which affects speech development and pronunciation in bilingual children. Overall, the review stresses the importance of studying speech sound acquisition in multilingual Indian contexts to better understand bilingual phonological development and improve assessment and intervention methods.

Chapter III

METHOD

The main objective of the present study was to investigate the speech sound development and accuracy in Kannada (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

The study included a total of 16 (8 children each in the 2 age groups) typically developing simultaneous bilingual Kannada-English speaking children in the age range of 4-5 years. The age range of 4 to 5 was divided into two subgroups with an age interval of six months (>4; 0 to ≤ 4; 6 and >4; 6 to ≤ 5; 0 years). The participants were selected from local preschools, anganwadis, and through parent networks.

16 typically developing simultaneous bilingual Kannada-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]). An equal sample size of 8 participants per subgroup was obtained. 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 Mysore as well as from Bangalore. The inclusion and exclusion criteria were as follows:

Inclusion criteria for the participants

a. In the age range of 4-5 years.
b. Native Kannada speakers, with exposure to both Kannada and English.
c. Simultaneous bilinguals with exposure to English (L2) before the age of 3 years.
d. Bilingual children with equal opportunity to use both L1 and L2 were ascertained by using the Questionnaire for parents (Shanbal & Prema, 2007)
e. With no history of structural, behavioural, cognitive, sensory, neurological, language problems or any syndromic diseases. WHO Ten-Question Disability Screening Checklist (Singhi et al., 2007) was used to screen the children.
f. Both parents were literate and proficient in both Kannada and English, and were tested by the Language Proficiency Questionnaire for Parents, LEAP-Q (Maitreyee & Goswami, 2009), with a minimum rating of 3 (Good) in all items.
g. Having adequate language age in both Kannada and English. Assessment Checklist for Speech-Language Skills (Swapna, Prema, & Geetha, 2010) was used to assess the receptive and expressive language skills of the participants.

Exclusion criteria

Children with

a. History of structural, behavioural, cognitive, sensory, neurological, language problems or any syndromic diseases.
b. Limited exposure to both languages.
c. Dominant exposure to multiple languages.
d. Sequential bilinguals, who have exposure to L2 after the age of 3.
e. Non-native Kannada-speaking parents or caregivers.

Table 3.1

Demographic details of the participants

Participants	Age	Gender	Age of onset of exposure to English	Child's strongest language
P1	4.0 years	Female	1.5 years	Predominantly Kannada
P2	4.0 years	Male	From birth	Predominantly English
P3	4.1 years	Female	1 year	Predominantly Kannada
P4	4.3 years	Female	From birth	Predominantly English
P5	4.3 years	Male	1.2 years	Predominantly Kannada
P6	4.5 years	Male	From birth	Predominantly Kannada
P7	4.5 years	Female	2 years	Predominantly Kannada
P8	4.6 years	Male	From birth	Speaks both equally well
P9	4.7 years	Male	2 years	Speaks both equally well
P10	4.7 years	Male	1.5 years	Predominantly Kannada
P11	4.10 years	Female	2.5 years	Predominantly Kannada
P12	4.11 years	Male	1.5 years	Predominantly Kannada
P13	5.0 years	Female	1 year	Predominantly Kannada
P14	5.0 years	Male	1.5 years	Predominantly Kannada
P15	5.0 years	Female	2 years	Predominantly Kannada
P16	5.0 years	Female	2 years	Predominantly Kannada

Test materials: The following test materials were administered on all participants in both languages.

3.3 Test Materials

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

Articulation Tests

a) Kannada Diagnostic Picture Articulation Test (Deepa & Savithri, 2010) - Kannada (Part I)

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

Stimulus words list from part I of KDPAT (Deepa & Savithri, 2010) and GFTA-3 (Goldman & Fristoe, 2015) were used to assess Consonant/Vowel accuracy (SODA analysis) and Whole Word Accuracy (WWA) & Proportion of Whole-Word Correctness (PWC).

A total of 10 vowels (/a/, /a:/, /i/, /i:/, /u/, /u:/, /e/, /e:/, /o/, /o:/) and 2 diphthongs (/ai, /au/) were tested in Kannada in the initial position and 9 vowels (/o:/, /ɪ/, /ʌ/, /æ/, /e/, /ə/, /ɑ/, /ɛ/, /a:/) and 3 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 Kannada, 21 consonants were tested in which 19 are in initial and medial positions, two are in medial positions only. In English, 23 consonants were tested: five are 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.

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 a Samsung Galaxy S24 mobile phone. A mobile application 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 analysed 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. Two of the participants (P4 and P11) were 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 Kannada and English using the single-word elicitation task of KDPAT 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 accuracy (SODA analysis)

2. Whole word accuracy (WWA) & 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 (Deepa Anand & Savithri, 2010) and GFTA-3 (Goldman & Fristoe, 2015) were transcribed using broad phonetic transcription (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 52 in part I of KDPAT and 60 in GFTA-3. Hence the scores of both the tests 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, cluster simplification, metathesis and epenthesis 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.

2. Whole word accuracy (WWA) & Proportion of Whole-Word Correctness (PWC)

All the words from the single-word elicitation task of KDPAT (Deepa Anand & Savithri, 2010) and GFTA-3 (Goldman & Fristoe, 2015) were analysed 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 (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 consonant correct using the following formula:

Percentage of consonant correct-Revised = Number of correct consonants / (number 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 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 Kannada-English bilingual Speech-Language pathologists, excluding the researcher transcribed 10% of the samples of articulation tests and story narration samples of both languages. For intra-judge reliability, 10% samples were reanalysed 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 utilised 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 (Kannada) and L2 (English) of Kannada-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: Group 1 (>4;0 to ≤ 4;6 years, n=8) and Group 2 (>4;6 to ≤ 5;0 years, n=8), giving a total of 16 participants. The speech samples of the participants were collected using standardised articulation tests and a connected speech task, which included a story narration in both languages. Stimulus words list from KDPAT (Deepa Anand & Savithri, 2010) and GFTA-3 (Goldman & Fristoe, 2015) were used to assess the outcome measures: (1) Consonant/Vowel accuracy and (2) Whole Word Accuracy (WWA) and 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 speech intelligibility and (4) Percentage of consonants correct-Revised (PCC-R). The results of the study are discussed under the following headings:

4.1 Speech sound development pattern in Kannada and English

4.2 Speech sound accuracy in Kannada and English

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

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

4.1 Speech sound development pattern in Kannada and English

Phoneme-wise analysis was carried out to examine speech sound development pattern in Kannada (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 and 2 diphthongs in Kannada 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 study considered 21 consonants in Kannada and 23 consonants in English. The results indicated that the number of children who correctly produce speech sounds 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 distortions, then omissions. The number of children with correct productions for singleton consonants across the two age groups in both Kannada and English are presented in Table 4.1 and Table 4.2 respectively.

In English, the number of children who correctly produced some phonemes varied across different words. In such cases, words produced by more number of children were considered. For instance, 5/8 children correctly produced the consonant /h/ in initial position in the word /haʊs/ whereas 7/8 correctly produced the same in initial position in /hæmər/. Hence the highest production seven 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 the Indian context colloquially. Usage of /s/ instead of /z/ was also accepted, as in the Indian context.

Table 4.1

Shows number of children with correct production of Kannada consonants in the 2 age groups

SI.No	Phonemes	Word positions	Correct Production	
			>4;0-≤4;6 (n=8)	>4;6-≤5;0 (n=8)
1.	/k/	Initial	8	8
		Medial	8	8
2.	/g/	Initial	8	8
		Medial	8	8
3.	/tʃ/	Initial	7	8
		Medial	8	8
4.	/dʒ/	Initial	8	8
		Medial	8	8
5.	/ʈ/	Initial	8	8
		Medial	5	6
6.	/ɖ/	Initial	8	8
		Medial	8	8
7.	/ɳ/	Medial	8	8
8.	/t̪/	Initial	8	8
		Medial	8	8
9.	/d̪/	Initial	8	8
		Medial	8	8
10.	/n/	Initial	8	8
		Medial	8	8
11.	/p/	Initial	8	8
		Medial	8	8
12.	/b/	Initial	8	8
		Medial	8	8
13.	/m/	Initial	8	8
		Medial	8	8
14.	/j/	Initial	8	8
		Medial	8	8
15.	/r/	Initial	6	8
		Medial	6	7
16.	/l/	Initial	8	8
		Medial	8	8
17.	/v/	Initial	8	8
		Medial	8	8
18.	/ʃ/	Initial	6	8
		Medial	8	8
19.	/s/	Initial	6	8
		Medial	7	8
20.	/h/	Initial	8	6
		Medial	5	4
21.	/ɭ/	Medial	7	8

Table 4.2

Shows the number of children with correct production of English consonants in the two age groups

Sl. No	Phonemes	Word positions	Correct production	
			>4;0-≤4;6 (n=8)	>4;6-≤5;0 (n=8)
1	/h/	Initial	8	7
2	/d/	Initial	8	8
		Medial	8	8
		Final	8	8
3	/p/	Initial	8	8
		Medial	8	8
		Final	8	8
4	/k/	Initial	8	8
		Medial	8	8
		Final	8	8
5	/b/	Initial	8	8
		Medial	8	8
6	/g/	Initial	8	8
		Medial	8	8
		Final	8	8
7	/t/	Initial	8	8
		Medial	8	8
		Final	8	8
8	/m/	Initial	8	8
		Medial	8	8
		Final	8	8
9	/f/	Initial	8	8
		Medial	8	8
		Final	8	8
10	/w/	Initial	8	8
11	/n/	Initial	8	8
		Medial	8	8
		Final	8	8
12	/ʃ/	Initial	8	8
		Medial	8	8
13	/s/	Initial	8	8
		Medial	8	8
		Final	8	8
14	/r/	Initial	7	8
		Medial	7	8
		Final	8	8
15	/θ/	Initial	8	8

		Final	8	8
16	/v/	Initial	8	8
		Medial	8	8
		Final	8	8
17	/dʒ/	Initial	8	8
		Medial	7	8
18	/j/	Initial	7	8
		Medial	8	8
19	/ð/	Initial	8	8
		Medial	8	8
20	/l/	Initial	8	8
		Medial	8	8
		Final	8	8
21	/tʃ/	Initial	8	8
		Final	8	8
22	/ŋ/	Medial	8	8
		Final	8	8
23	/z/	Initial	8	8
		Medial	8	8
		Final	7	7

4.1.3 Development of consonant clusters

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. The distributions of correct productions of clusters for both age groups in English are presented in Table 4.3. 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 example, 6/8 children correctly produced the consonant cluster /br/ in initial position in the word / brʌʃɪŋ/ whereas 8/8 correctly produced the same cluster in initial position in other word / brʌd̪ər/. Hence the highest production ie. By eight children is considered.

Table 4.3

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

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

4.2 Speech sound accuracy in Kannada and English

Statistical analysis was carried out using IBM SPSS (Version 26). The descriptive statistics were computed in both languages across both age groups for all four articulatory outcome measures, i.e., Consonant/Vowel accuracy, Whole Word Accuracy (WWA) & Proportion of Whole-word Correctness (PWC), Percentage of Consonants Correct-Revised (PCC-R) and Percentage of Speech intelligibility. The results are depicted in Table 4.4.

Table 4.4

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 - Kannada	>4;0-≤4;6	98.32	4.21	97.48	2.98
		>4;6-≤5;0	98.56	3.61	98.20	1.88
2	CV accuracy - English	>4;0-≤4;6	98.75	2.50	97.66	2.83
		>4;6-≤5;0	99.17	2.29	97.97	3.51
3	PWC-Kannada	>4;0-≤4;6	0.90	0.27	0.86	0.13
		>4;6-≤5;0	0.97	0.06	0.96	0.04
4	PWC-English	>4;0-≤4;6	0.97	0.05	0.95	0.06
		>4;6-≤5;0	0.98	0.04	0.96	0.07
5	PCC-R-Kannada	>4;0-≤4;6	99.52	3.55	98.56	1.79
		>4;6-≤5;0	99.11	1.05	98.97	1.43
6	PCC-R-English	>4;0-≤4;6	98.92	2.59	97.94	3.12
		>4;6-≤5;0	99.10	2.61	98.83	1.32
7	Speech intelligibility-Kannada (%)	>4;0-≤4;6	97.73	7.20	96.59	3.90
		>4;6-≤5;0	100.00	0.00	98.83	3.31
8	Speech intelligibility-English (%)	>4;0-≤4;6	99.00	4.25	97.76	3.22
		>4;6-≤5;0	98.12	2.56	98.37	1.58

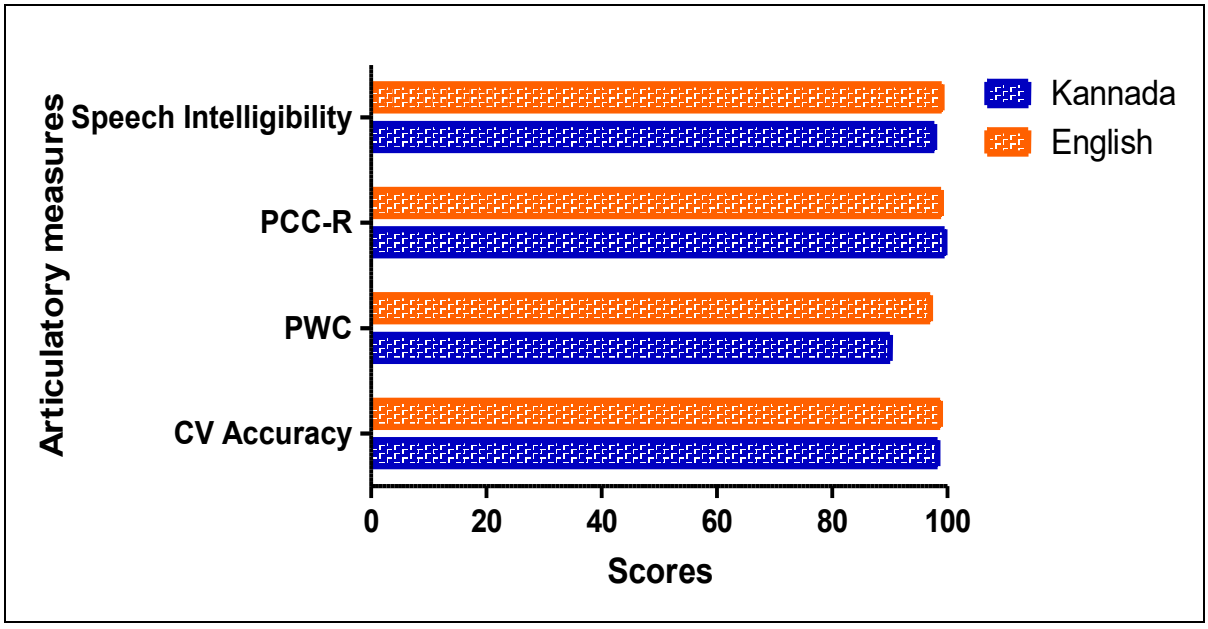
Note: CV accuracy= Consonant/Vowel accuracy, PWC= Proportion of Whole Word Correctness, PCC = Percentage of Consonants Correct, IQR= Interquartile Range, SD=Standard Deviation.

Table 4.4 reveals a significant improvement across the two age groups in both languages in most of the articulation outcome measures. Median CV accuracy increased from

98.32 in the younger group to 98.56 in the older group, while in English it improved from 98.75 to 99.17. PWC scores showed a notable increase in Kannada (0.90 to 0.97) and a marginal improvement in English (0.97 to 0.98) across the age groups. PCC median scores remained high for both languages and both groups, with Kannada ranging from 99.52 to 99.11 and English from 98.92 to 99.10. Speech intelligibility in Kannada showed a marked improvement in the median from 97.73% to 100%, while in English a slight decline from 99% to 98.12% was seen across the age groups. Overall, both languages demonstrated near ceiling articulatory accuracy across the two age groups. indicating speech sound accuracy improved with age, and the overall results are depicted in figure 4.1 and 4.2

Figure 4.1

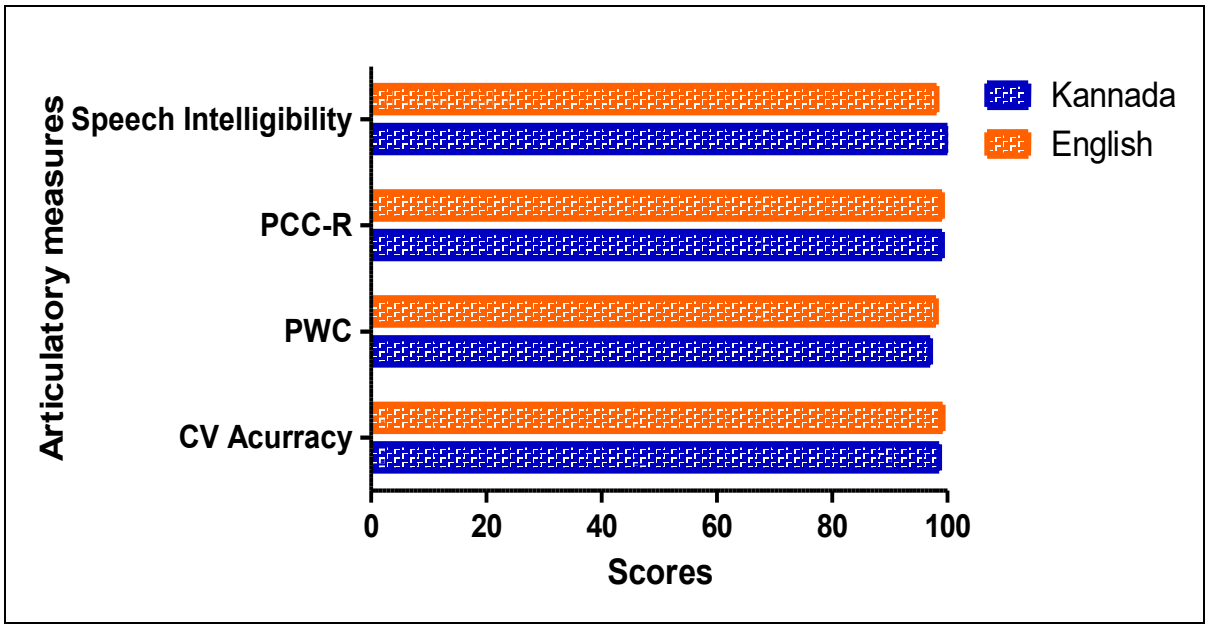
Shows the median articulatory outcome measures for Kannada and English in >4;0 to ≤4;6 years



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

Figure 4.2

Shows the median articulatory outcome measures for Kannada and English in >4;6 to ≤5;0 years



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

For inter-judge reliability, three speech language pathologists (SLPs) excluding the researcher transcribed 10% of the data and calculated all four articulatory outcome measures. Similarly for intra-judge reliability, 10% of the data (2 participants) was reanalysed 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 0.06 for PWC in Kannada, 0.05 for PWC in English and within 5% range for all other articulation outcome measures. Similarly, differences between two sets of scores assigned by the judge was within the range of 0.05 for PWC in Kannada, 0.03 for PWC in English and within 5% range for all outcome measures. These findings indicate high inter-judge and intra-judge reliability for all the articulatory outcome measures.

4.3 Comparison of speech sound accuracy in Kannada 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 (Table 4.6)

Table 4.5

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 (Kannada vs English)	.000	1.000
PWC (Kannada vs English)	2.117	.034*
PCC (Kannada vs English)	-.271	.786
Speech Intelligibility (Kannada vs English)	1.214	.225

Note. * p < .05. PWC = Proportion of Whole Word Correctness; PCC = Percentage of Consonants Correct. z values are based on the Wilcoxon Signed Rank test.

As depicted in Table 4.5, a statistically significant difference was observed between Kannada and English on the Proportion of Whole Word Correctness (PWC) in participants aged >4;0 to ≤4;6 years ($z = 2.117$, $p = .034$). Examination of the median values in Table 4.4 reveals that English PWC (Median = 0.97) was higher than Kannada PWC (Median = 0.90) in this age group, indicating comparatively better whole-word accuracy in English than in Kannada at this developmental stage. No statistically significant differences were found between Kannada and English in CV accuracy ($z = .000$, $p = 1.000$), PCC ($z = -.271$, $p = .786$),

or speech intelligibility (z = 1.214, p = .225), suggesting comparable performance in both languages on these three measures in the younger age group.

Table 4.6

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

Articulatory Measure	z Value	p Value
CV Accuracy (Kannada vs English)	.524	.600
PWC (Kannada vs English)	.333	.739
PCC (Kannada vs English)	-.140	.889
Speech Intelligibility (Kannada vs English)	-.677	.498

Note. * p < .05. PWC = Proportion of Whole Word Correctness; PCC = Percentage of Consonants Correct. z values are based on the Wilcoxon Signed Rank test.

As presented in Table 4.6, no statistically significant differences were observed between Kannada and English on any of the four articulatory outcome measures for participants in the older age group (>4;6 to ≤5;0 years). CV accuracy (z = .524, p = .600), PWC (z = .333, p = .739), PCC (z = −.140, p = .889), and speech intelligibility (z = −.677, p = .498) all yielded non-significant results. These findings indicate that bilingual children in the >4;6 to ≤5;0 years age range demonstrated comparable levels of articulatory accuracy in both Kannada and English across all four measures. Comparing the median values in Table 4.4, English scores were marginally higher on CV accuracy (99.17 vs 98.56) and PCC (99.10 vs 99.11, is approximately equal.) PWC scores (0.97 VS 0.98) were found to be approximately equal, while Kannada yielded a higher median for speech intelligibility (100.00 vs 98.12), although none of these differences reached statistical significance.

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

Comparison of articulatory outcome measures across the two age groups for both languages of 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 4.7.

Table 4.7

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

Articulatory outcome measures	/Z/ value	P value
CV acc. Kannada	.375	.721
CV acc. English	.743	.505
PWC Kannada	1.611	.130
PWC English	.916	.382
PCC-R Kannada	.000	1.000
PCC-R English	.270	.798
Sp. Inte. Kannada	1.277	.328
Sp. Inte. English	-.220	.878

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

As indicated in Table 4.4, the Mann–Whitney U test revealed no statistically significant differences across the two age groups for any of the four articulatory outcome measures (all $p > .05$). CV accuracy did not differ significantly between age groups in Kannada ($z = .375$, $p = .721$) or in English ($z = .743$, $p = .505$). Similarly, no significant age-group differences were found for PWC in Kannada ($z = 1.611$, $p = .130$) or English ($z = .916$, $p = .382$), PCC in

Kannada ($z = .000$, $p = 1.000$) or English ($z = .270$, $p = .798$), or speech intelligibility in Kannada ($z = 1.277$, $p = .328$) or English ($z = -.220$, $p = .878$). These findings suggest that the two age groups performed at a comparable level across all articulatory outcome measures in both languages, with no statistically significant age-related improvements detected over the six-month interval examined.

Overall, the results reveal that Kannada–English simultaneous bilingual children in the 4 to 5-year age range demonstrate high and comparable levels of speech sound accuracy in both languages across all four outcome measures. A statistically significant language difference was observed only in PWC for the younger age group (>4;0 to ≤4;6 years), with English scores exceeding Kannada, suggesting that whole-word accuracy in English develops slightly ahead of Kannada at this stage. No significant differences were observed across the two age groups for either language, indicating that articulatory accuracy was largely stable within this developmental window of 4 to 5 years in typical bilingual children.

Chapter V

DISCUSSION

The present study investigated the speech sound development and phoneme accuracy in both Kannada (L1) and English (L2) among typically developing Kannada-English simultaneous bilingual children aged 4 to 5 years. The participants were divided into two subgroups based on age: Group 1 (>4;0 to ≤4;6 years, n = 8) and Group 2 (>4;6 to ≤5;0 years, n = 8). Four articulatory outcome measures were assessed: Consonant/Vowel (CV) accuracy, Proportion of Whole-Word Correctness (PWC), Percentage of Consonants Correct-Revised (PCC-R), and Percentage of Speech Intelligibility. The findings are discussed under the following headings in relation to existing literature, highlighting studies that both support and contrast the current results.

5.1 Speech Sound Development Pattern in Kannada and English

Vowels and Diphthongs

The results of the present study revealed that all vowels and diphthongs in both Kannada and English were correctly produced by all 16 participants by the younger age group (>4;0 to ≤4;6 years), indicating early and complete mastery of the vowel system in both languages. This finding is consistent with prior research on bilingual children of Indian heritage. Lim and Chieng (2021) reported that English-Malay bilingual children of Indian heritage acquired all vowels by 2;11 years, suggesting that vowels are among the earliest phonological elements to be mastered in bilingual populations. Similarly, Kehoe (2002) noted that in Spanish-German bilingual children, vowel acquisition progressed comparably to monolingual peers, with language-specific vowel contrasts emerging early in development.

These studies collectively support the finding that the vowel system is relatively robust in simultaneous bilinguals.

In the Indian context, Bansal and Kumaraswamy (2023) found that most vowels in Hindi were acquired by age 4, although certain vowels such as the medial /ɔː/ showed delayed mastery until age 5. Kehoe (2002) similarly observed that in bilingual children, long vowels and diphthongs may continue to stabilise until around 5 years, particularly in languages with phonemic length contrasts such as Kannada, where vowel length is phonemically contrastive. The present study's finding that all Kannada vowels and diphthongs were acquired by the younger age group aligns broadly with these trajectories, though the specific phonemic distinctions of Kannada vowels (short-long pairs and diphthongs /ai/ and /au/) were successfully mastered earlier than some studies might predict for bilingual children. This may reflect the high degree of input consistency in the participants' home environments, where Kannada was the dominant language for most children.

Singleton Consonants

The findings indicated that most singleton consonants in both Kannada and English were correctly produced by the majority of participants across both age groups, with an increase in correct productions from Group 1 to Group 2. Substitution was identified as the most common error type, followed by distortions and then omissions. These findings are broadly consistent with developmental studies in both monolingual and bilingual populations.

For Kannada consonants, the present study found that early-acquired consonants such as stops (/k/, /g/, /t̪/, /d̪/, /p/, /b/), nasals (/m/, /n/, /ɳ/), affricates (/tʃ/, /dʒ/), and glides (/j/, /v/) were correctly produced by all 8 children in both age groups, while later-developing sounds such as /r/, /ʃ/, /s/, and /h/ showed more variability, particularly in the younger group. This developmental sequence aligns with findings by Prathima and Sreedevi (2009), who reported

that most unaspirated Kannada consonants across bilabial, palatal, dental, velar, and retroflex places were acquired by 3;0 to 3;6 years, with /r/ and /h/ showing the greatest articulatory complexity and therefore later mastery. The present study extends this finding to a bilingual population, suggesting that the general acquisition hierarchy in Kannada is preserved even in the context of simultaneous bilingualism.

A notable finding was the variability observed in /ʈ/ in the medial position (5/8 in Group 1, 6/8 in Group 2) and /h/ in both initial and medial positions (showing a slight decline from Group 1 to Group 2 in both positions). The retroflex /ʈ/ is a sound unique to mostly Indian languages and requires precise tongue-tip placement in the retroflex region; its relatively later acquisition is consistent with reports that retroflexes are among the more complex sounds for children to master (Bathina et al., 2022). The unexpected variability in /h/ production may reflect dialectal or positional effects. Also, Deepa and Savithri (2010) reported a late acquisition of /h/, perhaps due to the deletion of /h/ in colloquial adult Kannada usage. Earlier studies on Kannada monolingual children (Tasneem Banu, 1977, as cited in Prathima & Sreedevi, 2009) did not isolate /h/ as a consistently problematic sound, suggesting that bilingual exposure may introduce some inconsistency in the production of this phoneme, possibly due to differing phonotactic roles of /h/ in Kannada and English.

For English, the present study found that most consonants were correctly produced by all children in both age groups. Sounds such as /r/ and /j/ showed some variability in Group 1 (7/8 children) but improved to full mastery or near-full mastery in Group 2. Crowe and McLeod (2020), in a comprehensive review of English consonant acquisition across 27 countries, found that by 4 to 5 years of age, most children acquire stops, nasals, fricatives, and affricates, with liquids (/r/, /l/) and certain fricatives (/θ/, /ð/) showing the latest acquisition. The current findings are consistent with this trajectory, as /l/ was mastered across all positions by all

children in both groups, while /r/ showed slight variability in the younger group. The acceptance of dialectal variants of /θ/ and /ð/ as dental stops (/t̪/, /d̪/) and nasal /ŋ/ as /ŋk/ in the present study is an important methodological consideration and reflects the phonological influence of Kannada (an L1 that lacks interdental fricatives) on English production, a pattern that has been documented in the speech of Indian English speakers across generations (Chervela, 1981; Craft, 2024).

In contrast to the predominantly high accuracy observed in the present study, some studies have reported more variable or delayed consonant acquisition in bilingual children. Hambly et al. (2012) conducted a systematic review and found evidence of deceleration in phonological development among bilingual children compared to monolingual norms, particularly for language-specific sounds. However, Hambly et al. also noted that this deceleration is not universal and is often related to the relative dominance of each language and the degree of phonological overlap between them. In the present study, Kannada was identified as the dominant language for most participants, which likely facilitated high accuracy in Kannada consonant production and also scaffolded performance in English, given the phonological similarities between the two languages (such as shared bilabial, velar, and palatal stops).

Consonant Clusters

The results demonstrated that most English consonant clusters tested were produced correctly by most children in both age groups, with an increase in correct productions from Group 1 to Group 2. The most common error types in cluster production were substitution of one or more consonants within the cluster and coalescence. These findings are consistent with broader developmental trajectories reported for English consonant clusters.

Dyson (1988) found that simple two-element English clusters such as /br/, /bl/, /kw/, and /sp/ emerge between 2;0 and 3;3 years in monolingual English-speaking children. The present study found that clusters such as /br/, /bl/, /sp/, and /kw/ were produced correctly by nearly all participants in both age groups, suggesting that these clusters are well within the developmental capacity of Kannada-English bilingual children by age four. More complex clusters such as /dr/, /pl/, /sl/, /fr/, /pr/, /kr/, and /tr/ showed slight variability (7/8 children in one or both groups), which aligns with the expectation that clusters involving liquids (/l/, /r/) are typically acquired later due to the greater articulatory demands of combining a stop or fricative with a rhotic or lateral.

Lim and Chieng (2021), in their study of English-Malay bilingual children of Tamil Indian heritage, found that English consonant clusters were acquired earlier than would be predicted by monolingual English norms, hypothesising that the presence of similar cluster structures in Tamil may facilitate their acquisition in English. While Kannada has a different cluster inventory compared to English, with predominantly medial clusters in native Kannada words (Divyashree & Sreedevi, 2018), the shared consonants between the two languages (such as stops, nasals, and affricates) may provide phonological scaffolding for English cluster production. This cross-linguistic facilitation hypothesis (Kehoe & Lleó, 2003) may partly explain the high cluster accuracy observed in the present study, particularly for clusters involving shared consonants.

Divyashree and Sreedevi (2018) found that most Kannada consonant clusters were acquired by 5.6 years in monolingual Kannada-speaking children, with simpler clusters being mastered earlier. The present study did not test Kannada clusters directly; however, the high English cluster accuracy observed suggests that the bilingual children in this study were not disadvantaged in cluster production relative to monolingual expectations, aligning with

McLeod and Crowe's (2020) finding that most English clusters are within developmental norms by age five.

5.2 Speech Sound Accuracy in Kannada and English

Across all four articulatory outcome measures and both age groups, the children in the present study demonstrated near-ceiling performance in both Kannada and English. The median CV accuracy ranged from 98.32 to 99.17, PWC from 0.90 to 0.98, PCC-R from 98.92 to 99.52, and speech intelligibility from 97.73% to 100% across the two age groups and both languages. These high accuracy values are broadly consistent with findings from studies on both monolingual and bilingual children in the 4 to 5-year age range.

Crowe and McLeod (2020) reported that typically developing English-speaking children achieve a percentage of consonants correct of approximately 90 to 100% by 5 years of age. The PCC-R values obtained in the present study (medians exceeding 98% for both languages and both groups) are well within this range, suggesting that Kannada-English simultaneous bilinguals in this age group achieve comparable consonant accuracy to monolingual peers. This is consistent with the findings of Gildersleeve-Neumann et al. (2008), who examined Spanish-English bilingual children and found that overall consonant accuracy was comparable to monolingual norms in both languages, provided that children received adequate exposure to both languages.

With respect to PWC, the present study found a median value of 0.90 in the younger group for Kannada, increasing to 0.97 in the older group. In English, PWC was higher in the younger group (0.97) and increased marginally to 0.98 in the older group. PWC is a measure of whole-word accuracy that penalises any deviation from the target word form, hence lower values reflect greater phonological complexity in production. Ingram and Ingram (2001)

developed PWC as a sensitive measure of phonological accuracy, and subsequent studies have confirmed that it improves systematically with age in typically developing children. The present study's values are in line with those reported for children in this age range, indicating that the bilingual children were achieving high whole-word accuracy in both languages by the 4 to 5-year age window.

Speech intelligibility scores were also high across both languages and age groups, with Kannada intelligibility reaching a median of 100% in the older group and English intelligibility being consistently above 97% in both groups. These values are consistent with developmental expectations. Flipsen (2006) established that typically developing children achieve approximately 75% intelligibility to unfamiliar listeners by 3 years of age and approach 100% by 5 years. In Kannada, Shishira and Sreedevi (2010) reported near 100% speech intelligibility by four years even to strangers. The present findings suggest that Kannada-English simultaneous bilinguals achieve similar intelligibility milestones, and that bilingualism itself does not compromise speech intelligibility in either language by this age. Studies such as Fabiano-Smith and Barlow (2009) and McLeod and Verdon (2017) have similarly highlighted simultaneous bilinguals, when receiving adequate input in both languages, achieve intelligibility levels comparable to monolingual norms.

An inference from findings is that 4.0 to 4.6 years and 4.6 to 5.0 years shows comparable speech sound accuracy, as these sounds are achieved before 4 years by typically developing Kannada English bilingual children. This suggests that present day children’s phonological development is much more advanced irrespective of monolingual or bilingual exposure. Some of the reasons may be because of:

- Exposure to both languages by the age of 3 years

- Educated parents (graduates or post-graduates) can enhance earlier acquisition in children due to better speech inputs.
- Socio-economic status of the family (upper middle class).
- Usage of TV, mobile phones, and exposure from daycare where they get constant input from teachers and peers.
- Better care and nutrition.

All these factors can improve their articulatory development pace.

5.3 Comparison of Speech Sound Accuracy in Kannada and English Within Age Groups

The Wilcoxon Signed Rank test revealed that in the younger age group (>4;0 to ≤4;6 years), a statistically significant difference was found between Kannada and English in PWC ($z = 2.117$, $p = .034$), with English PWC being higher than Kannada PWC (medians of 0.97 vs. 0.90, respectively). No significant differences were found for CV accuracy, PCC-R, or speech intelligibility within this age group. In the older age group (>4;6 to ≤5;0 years), no statistically significant differences were found between Kannada and English on any of the four measures.

The finding that English PWC was significantly higher than Kannada PWC in the younger group suggests further discussion. PWC is sensitive to whole-word accuracy, and a lower Kannada PWC relative to English may suggest that children in the younger group produced more whole-word deviations in Kannada than in English. One of the other reasons may be transfer of few sounds from English to Kannada such as /r/, which was mainly seen in children whose parents worked in USA, or children who watched cartoons in English. The words assessed in Kannada by the KDPAT include phonologically complex items featuring

retroflexes, specific cluster combinations, and geminate consonants that may be challenging for children at the very beginning of the 4 to 5-year range. In English, the GFTA-3 items are standardised for English monolingual children, and many of the sounds tested (stops, nasals, fricatives) are shared between Kannada and English, potentially enabling higher whole-word accuracy in English for the younger group.

This pattern is consistent with the notion of cross-linguistic influence in simultaneous bilinguals. Scarpelli and Core (2015) noted that simultaneous bilinguals may show asymmetric performance across their two languages, particularly in measures sensitive to phonological complexity, even when overall accuracy is high. Kehoe and Girardier (2020) observed that vocabulary size and language exposure were predictors of phonological accuracy, and that children with higher exposure to one language tended to show higher accuracy in that language. Given that most participants in the present study were identified as predominantly Kannada speakers, it might be expected that Kannada accuracy would be higher; however, the higher English PWC in the younger group may indicate that the English lexical items tested were phonologically less demanding in terms of whole-word complexity compared to the Kannada items.

In contrast, Fabiano-Smith and Goldstein (2010) found that Spanish-English simultaneous bilinguals did not show systematic differences in consonant accuracy between their two languages, suggesting that cross-linguistic effects on phonological accuracy may depend heavily on the specific language pair and the phonological demands of the assessment materials used. The present finding of a significant Kannada-English PWC difference only in the younger group and its disappearance in the older group suggests a developmental resolution of this asymmetry, potentially reflecting the stabilisation of Kannada phonological representations with increasing age and exposure.

5.4 Comparison of Speech Sound Accuracy Across Age Groups for Kannada and English

The Mann-Whitney U test revealed no statistically significant differences between the two age groups on any of the eight articulatory outcome measures across both languages (all $p > .05$). This finding indicates that Kannada-English simultaneous bilingual children in the two age bands (>4;0 to ≤4;6 and >4;6 to ≤5;0 years) demonstrated comparable articulatory accuracy across all measures in both languages, with no statistically significant age-related improvement detected within this six-month interval.

The absence of significant cross-age differences can be interpreted in at least two ways. First, the near-ceiling performance observed across both groups may reflect a genuine plateau in measurable articulatory accuracy by this developmental stage. By age 4, most typically developing children have acquired the majority of their consonant inventory, and measures such as PCC-R and CV accuracy are likely to be at or near ceiling, leaving little room for statistically significant improvement over a six-month interval. This interpretation is consistent with the literature. McLeod and Crowe (2020) noted that the steepest period of consonant acquisition in English occurs between 2 and 4 years, with accuracy approaching mastery by 4 to 5 years. Similarly, Prathima and Sreedevi (2009) found that most Kannada consonants were acquired by 3 to 4 years in monolingual children. If singleton consonant accuracy is largely stable by 4 years, the six-month window examined in the present study may simply not capture significant developmental change.

Second, the small sample size (n = 8 per group) may have limited statistical power to detect subtle age-related differences, particularly given the near-ceiling distributions and low variance in many measures. Ruiz-Felter et al. (2016) have noted that small sample sizes are a persistent limitation in bilingual phonological development research, and that effect sizes may be masked by floor or ceiling effects in standardised articulation measures. Future studies with

larger samples and wider age ranges may be better positioned to detect within-age differences in this population.

Interestingly, the PWC values in Kannada showed a marked descriptive improvement from 0.90 (Group 1) to 0.97 (Group 2), and the speech intelligibility median in Kannada reached 100% in the older group compared to 97.73% in the younger group. While these differences did not reach statistical significance, they suggest clinically meaningful improvement in whole-word accuracy and intelligibility, particularly in Kannada, over the six-month developmental interval. Lim and Chieng (2021) reported similar descriptive trends in English-Malay bilingual children, where whole-word accuracy improved over short developmental intervals even when statistical significance was not reached due to small sample sizes. These trends underscore the importance of considering effect sizes and clinical meaningfulness alongside statistical significance in paediatric speech development research.

The finding of no significant age-group differences also contrasts with studies in other bilingual populations. Kehoe and Havy (2018) found significant age-related improvements in consonant accuracy in French-English bilingual children between 3 and 5 years, particularly in their minority language. However, those children were assessed across a wider age range (3;0 to 5;0 years), spanning a developmental window that naturally encompasses greater phonological change. The narrower 4 to 5-year interval in the present study is possibly insufficient to capture comparable developmental shifts as most speech sound acquisition is completed by then.

5.5 Error Patterns and Cross-Linguistic Influence

Substitution was identified as the most common error type in both languages, followed by distortions and omissions. This hierarchical pattern is consistent with the general

developmental literature. Stoel-Gammon (1985) noted that substitutions are the predominant error type in typically developing children, reflecting the gradual differentiation of phonological categories, while omissions are more characteristic of younger children or those with speech sound disorders. The predominance of substitutions over omissions in the present study is therefore developmentally appropriate for the 4 to 5-year age range.

In Kannada, substitutions involving retroflex consonants (particularly /ʈ/ in medial position) were among the more common error patterns in the younger group. This finding aligns with prior Indian language research. Bathina et al. (2022) reported that retroflex consonants are among the most articulatorily complex sounds in Indian languages, and their mastery may lag behind other consonants due to the precise tongue-tip placement required. The present study's observation that /ʈ/ in medial position was not fully mastered by all children in the younger group, and only partially improved in the older group, suggests that even in a language where retroflexes are native (Kannada), articulatory refinement of these sounds continues little beyond 4 years.

In English, several substitution patterns reflected cross-linguistic transfer from Kannada. The acceptance of dental stop realisations of /θ/ (as /t̪/) and /ð/ (as /d̪/) was motivated by the absence of interdental fricatives in Kannada; similar substitutions have been documented in the speech of Indian English speakers and are considered normative features of Indian English rather than errors (Chervela, 1981; Craft, 2024). The use of /s/ in place of /z/ in some items, and the substitution of /ŋk/ for /ŋ/ in words with the /ŋ/ phoneme in final position, also reflect L1 phonotactic constraints. Kannada, like many Dravidian languages, restricts the distribution of voiced fricatives and nasals in certain positions, and these constraints appear to influence children's English production, consistent with the phonological transfer framework described by Fabiano-Smith and Goldstein (2010).

The error patterns observed in the present study, while limited in scope relative to detailed phonological process analyses, provide preliminary evidence for cross-linguistic influence in Kannada-English simultaneous bilinguals. Bailoor and Krishnan (2014) conducted a study on sequential Kannada-English bilinguals aged 3 to 4 years and identified 14 phonological processes, the most common being fronting, cluster reduction, epenthesis, initial consonant deletion, and affrication. The present study's simultaneous bilingual participants showed considerably fewer and less severe error patterns than those reported for sequential bilinguals, consistent with the expectation that simultaneous bilingualism supports stronger phonological representations in both languages from an earlier age (de Houwer, 2009; Paradis et al., 2004).

Chapter VI

SUMMARY AND CONCLUSIONS

The study investigated the speech sound development and phoneme accuracy of typically developing Kannada-English simultaneous bilingual children in the age range of 4 to 5 years. A total of 16 participants were considered in this 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]). An equal sample size of 8 participants per subgroup was obtained. The four articulatory outcome measures assessed were: Consonant-Vowel (CV) Accuracy, Whole word accuracy measures and proportion of whole-word correctness, Percentage of consonants correct (PCC-R), and Percentage of speech intelligibility. The study utilised articulatory tests namely Kannada Diagnostic Picture Articulatory Test (Deepa & Savithri, 2010) and Goldman-Fristoe Test of Articulation - 3rd edition (Goldman & Fristoe, 2015) with a story narration of 'The Thirsty Crow' in both languages.

The results revealed that all vowels and consonants in both Kannada and English were correctly produced by all the participants in the younger age group only. This indicated early mastery of vowels before the age of 4 years in both languages. Majority of the singleton consonants were also correctly produced by both age groups, however the few errors types seen were identified was substitution, followed by distortion and omission. Early acquired consonants such as stops, nasals, affricates and glides were mastered by participants from both groups in both languages. Later developing sounds such as /r/, /ʃ/, /s/, and /h/ in Kannada and /r/ and /j/ in English showed some variability in the younger group, improving with age. Consonant clusters in English were mostly produced correctly by both age groups, where the primary error types were substitutions and coalescence. The participants demonstrated near ceiling performance in both languages for all four articulatory outcome measures. Median CV accuracy ranged from 98.32 to 99.17, PWC from 0.90 to 0.98, PCC-R from 98.92 to 99.52, and

speech intelligibility from 97.73% to 100% across the two age groups, which was consistent with the expectations for typically developing children in this age range.

The statistical comparisons across languages using the Wilcoxon Signed Rank test revealed a significant difference between Kannada and English on Proportion of Whole Word Correctness (PWC) in the younger age group (>4;0 to ≤ 4;6 years, z= 2.117, p = 0.034), with English PWC (median= 0.97) being significantly higher than Kannada PWC (median=0.90). This difference was not seen for CV accuracy, PCC-R, and speech intelligibility in the same age group. And no significant language differences were found for any of the four outcome measures in the older age group (>4; 6 to ≤ 5; 0 years). The Mann-Whitney U test revealed no statistically significant differences between the two age groups on any of the four articulatory outcome measures in either language (all p> 0.05), suggesting comparable performance across the six-month developmental interval. How ever in the older group, PWC improved from 0.90 to 0.97 and speech intelligibility reached a median of 100% in Kannada. This indicates clinically meaningful developmental progress in articulation. Evidences of cross lingual transfer was observed in English production particularly in the use of interdental /θ/ and /ð/ as /t̪/ and /d̪/ respectively and substitution patterns influenced by Kannada phonotactics, consistent with the phonological transfer framework described in the bilingual acquisition literature.

In conclusion, Kannada English simultaneous bilingual children from ages 4 to 5 were found to possess high levels of articulatory accuracy in both the languages, being comparable with each other. And the results achieved were congruent with the expectations in terms of development for both the monolingual as well as bilingual population. Statistically significant cross linguistic differences could be seen only for the Proportion of Whole Word Correctness in the younger age group, which disappeared in the older age group. It indicated that there was a developmental resolution to the initial dissimilarities that existed among the whole word

phonological complexities. The absence of significant difference between the two groups may have been due to near-ceiling achievement by the age of 4 itself as the current study included an age span of 4 to 5 years. The results obtained indicate preliminary normal data for Kannada English simultaneous bilinguals and highlight the need for assessing bilingual individuals in Speech Language Pathology.

Limitations of the study

1. The number of participants included in the study is small limited the statistical power and prevented the use of parametric analyses. As a result, the findings cannot be readily generalised to a wider population of Kannada English simultaneous bilinguals.
2. Recruitment of participants was primarily from urban areas of Mysore and Bangalore, which reduces representativeness.
3. The study focused only on children aged 4 to 5 years, leaving the logarithmical phonological development earlier to this range unexplored.
4. Standardised single word articulation tests and a story narration task were used which may not capture the phonological errors in connected speech fully.
5. The articulation test in Kannada considered only part I of KDPAT due to time constraints, hence it missed information on clusters in this population since only part II of KDPAT includes clusters in Kannada.
6. Potential gender related differences in speech sound accuracy and developmental trajectory were not examined.

Clinical implications

1. Provide a preliminary benchmark for speech language pathologists when assessing Kannada English simultaneous bilingual children aged 4 to 5 years. These descriptive

norms can serve as a reference point for distinguishing typical bilingual variations from speech sound disorders.

2. The cross linguistic transfer patterns identified in the study and the influence of Kannada on English words can be considered as normative features of bilingual population rather than an indicator of speech sound disorder. Misinterpreting these patterns as pathology risks over-identification in clinical practice
3. Articulation assessments should be administered in both languages in a simultaneous bilingual population. Assessing only one language can lead to misinterpretation and misdiagnosis.
4. Provides a baseline for linguistically appropriate assessment tools tailored to Kannada-English speaking bilinguals.
5. Helps in appropriate intervention planning, considering bilingual factors such as dominance, exposure of each language, etc.
6. Helps in parent counselling and reassuring caregivers by providing an evidence-based explanation of bilingual speech sound development, reducing anxiety.

Future directions

1. Future studies should include a larger number of participants to strengthen the findings and to build reliable reference data. It can also help in studying the differences in gender, socioeconomic status and language dominance.
2. Longitudinal studies from early childhood (younger than 4 years) can be considered for future studies to map the speech sound development and its trajectory in simultaneous bilingual children.
3. Studies can include large connected speech samples to get a detailed picture of bilingual phonology and phonological processes involved when exposed to both Kannada and English in simultaneous bilingual children.

4. Studies can include participants from other areas of Karnataka to see if the findings apply beyond urban centres like Mysore and Bangalore.
5. Future studies can compare the bilingual group to a monolingual Kannada control group to compare the differences and similarities across age and gender.

REFERENCES

Ali Addow, A., Omar, S. I., & Mohamud, A. A. (2025). An analysis of phonetic and phonological systems in classical Arabic and English: a contrastive study. *Cogent Education*, *12*(1), 2549514. https://doi.org/10.1080/2331186X.2025.2549514

Arora, V., Lahiri, A., & Reetz, H. (2018). Phonological feature-based speech recognition system for pronunciation training in non-native language learning. *The Journal of the Acoustical Society of America*, *143*(1), 98-108. https://doi.org/10.1121/1.5017834

Bailoor, M., & Krishnan, G. (2014). Phonological processes in Kannada-English bilingual children (3-4 years). Journal of the Indian Speech and Hearing Association, 28(1), 12–21.

Bailoor, P., Rai, M., & Krishnan, L. (2014). Development of phonological processes in typically developing 3-4-year-old Indian bilingual children. *Development*, *23*.

Bansal, H., & Kumaraswamy, S, (2023). Revised Picture Articulation Test in Hindi. *International Journal for Research in Applied Science and Engineering Technology*, 11(8), 117-118

Bansal, R., & Kumaraswamy, V. (2023). Speech sound acquisition in Hindi-speaking children. Journal of Speech and Language Pathology, 21(2), 45–59.

Bathina, R., Sreedevi, N., & Suresh, M. (2022). Retroflex consonants in Kannada-speaking children: Articulatory characteristics and developmental patterns. Journal of Phonetics and Speech Sciences, 14(1), 23–38.

Bathina, S., Garibaldi, A., & Venkatesh, L. (2023). Validation of the Intelligibility in Context Scale in Tamil (ICS-Tamil) and insights into children's speech sound accuracy. *Speech, Language and Hearing*, *26*(1), 61-73.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In O. S. Bohn & M. J. Munro (Eds.), Language experience in second language speech learning: In honour of James Emil Flege (pp. 13–34). John Benjamins.

Bharadwaj, S. S., Sushma, S., & Sreedevi, N. (2010). Speech intelligibility in (3-4 years old) typically developing children. *Journal of All India Institute of Speech and Hearing*, *29*(1), 81-86.

Chervela, N. (1981). Medial consonant cluster acquisition by Telugu children. Journal of Child Language, 8(1), 63–73. https://doi.org/10.1017/S0305000900003032

Chung, S. C., Chen, X., & Geva, E. (2019). Deconstructing and reconstructing cross-language transfer in bilingual reading development: An interactive framework. *Journal of Neurolinguistics, 50*, 149–161. https://doi.org/10.1016/j.jneuroling.2018.01.003

Clausen, M., Jørgensen, P. E., Bøgh, M. S., & Fox-Boyer, A. (2022). Intraword variability in 2-year-old typically developing Danish-speaking children.

Craft, J. (2024). Phonological interference in Indian English: A study of L1 Kannada speakers. International Journal of Applied Linguistics, 34(2), 200–218.

Craft, J. (2024). *The effect of listener experience and social expectation on illusory percepts* (Doctoral dissertation).

Crowe, K., & McLeod, S. (2020). Children's English consonant acquisition in the United States: A review. American Journal of Speech-Language Pathology, 29(4), 2155–2169. https://doi.org/10.1044/2020_AJSLP-19-00168

Curtin, S., & Zamuner, T. S. (2014). Understanding the developing sound system: Interactions between sounds and words. *Wiley Interdisciplinary Reviews: Cognitive Science*, *5*(5), 589-602.

De Houwer, A. (1996). Bilingual language acquisition. *The handbook of child language*, 219-250.

De Houwer, A. (2009). *Bilingual first language acquisition* (Vol. 2). Multilingual Matters.

Deepa Anand, & Savithri, S. R. (2010). Kannada Developmental Phonological Assessment Tool (KDPAT). All India Institute of Speech and Hearing.

Divyashree, S., & Sreedevi, N. (2018). Acquisition of consonant clusters in Kannada-speaking children: A developmental study. Journal of the All India Institute of Speech and Hearing, 37(1), 45–60.

Dyson, A. T. (1988). Phonetic inventories of 2- and 3-year-old children. Journal of Speech and Hearing Disorders, 53(1), 89–93. https://doi.org/10.1044/jshd.5301.89

Edwards, J., & Beckman, M. E. (2008). Some cross-linguistic evidence for modulation of implicational universals by language-specific frequency effects in phonological development. *Language learning and development*, *4*(2), 122-156.

Ekström, A. G. (2022). Motor constellation theory: A model of infants' phonological development. *Frontiers in Psychology*, *13*, 996894.

Ellis, R. (1997). Second language acquisition. *The United States: Oxford*, *98*, 37.

Fabiano-Smith, L., & Barlow, J. A. (2009). Interaction in bilingual phonological acquisition: Evidence from phonetic inventories. International Journal of Bilingual Education and Bilingualism, 13(1), 81–97. https://doi.org/10.1080/13670050902783420

Fabiano-Smith, L., & Goldstein, B. A. (2010). Phonological acquisition in bilingual Spanish-English speaking children. Journal of Speech, Language, and Hearing Research, 53(1), 160–178. https://doi.org/10.1044/1092-4388(2009/07-0064)

Fabiano-Smith, L., Stapleton, A., & Arriaga, D. (2021). Phonological accuracy in bilingual Spanish-English children: New evidence for the interdependence hypothesis. American Journal of Speech-Language Pathology, 30(2), 631–645. https://doi.org/10.1044/2020_AJSLP-20-00151

Fernandes, F. (2017). *Advances in speech-language pathology*. IntechOpen. The Shard 25th floor, 32 London Bridge Street, London, SE19SG, UK.

Flege, J. E. (1995). Second language speech learning: Theory, findings, and problems. In W. Strange (Ed.), Speech perception and linguistic experience: Issues in cross-language research (pp. 233–277). York Press.

Flipsen, P. (2006). Measuring the intelligibility of conversational speech in children. Clinical Linguistics and Phonetics, 20(4), 303–312. https://doi.org/10.1080/02699200400024863

Fox-Boyer, A., Lavaggi, S., & Fricke, S. (2022). Phonological variations in typically-developing Italian-speaking children aged 3; 0-4; 11. *Clinical Linguistics & Phonetics*, *36*(2-3), 241-259. https://doi.org/10.1080/02699206.2021.1945686

Gildersleeve-Neumann, C. E., Kester, E. S., Davis, B. L., & Peña, E. D. (2008). English speech sound development in preschool-aged children from bilingual English–Spanish environments. Language, Speech, and Hearing Services in Schools, 39(3), 314–328. https://doi.org/10.1044/0161-1461(2008/030)

Goldman, R., & Fristoe, M. (2015). Goldman-Fristoe Test of Articulation (3rd ed.) [GFTA-3]. Pearson.

Grech, H. (2000). Cross linguistic comparison of phonotactic development. *South African Journal of Communication Disorders*, *47*(special), 35-43.

Green, J. R., Moore, C. A., Higashikawa, M., & Steeve, R. W. (2000). The physiologic development of speech motor control: Lip and jaw coordination. *Journal of Speech, Language, and Hearing Research*, *43*(1), 239-255.

Gunhal, P. R. (2025). Suffix-Aware AI-Driven Pronunciation Evaluation for Kannada Language Learning in Diaspora Student Education. In *ITM Web of Conferences* (Vol. 79, p. 01011). EDP Sciences.

Hambly, H., Wren, Y., McLeod, S., & Roulstone, S. (2012). The influence of bilingualism on speech production: A systematic review. International Journal of Language and Communication Disorders, 48(1), 1–24. https://doi.org/10.1111/j.1460-6984.2012.00178.x

Hancock, R., Pugh, K. R., & Hoeft, F. (2017). Neural noise hypothesis of developmental dyslexia. *Trends in Cognitive Sciences, 21*(6), 434–448. https://doi.org/10.1016/j.tics.2017.03.008

Hecht, B. F., & Mulford, R. (1982). The acquisition of a second language phonology: Interaction of transfer and developmental factors. Applied Psycholinguistics, 3(4), 313-328.

Ingram, D., & Ingram, K. D. (2001). A whole-word approach to phonological analysis and intervention. Language, Speech, and Hearing Services in Schools, 32(4), 271–283. https://doi.org/10.1044/0161-1461(2001/025)

Kamsinah, K., &Natsir, N. (2025). Contrastive analysis of Indonesian and English Phonological Systems: Implications for Pronunciation Teaching. *International Journal of Educations Research.* 2(3). 44-52.

Kan, P. F., & Kohnert, K. (2021). Cross-linguistic transfer of phonological skills in sequential bilingual children. Journal of Child Language, 48(3), 567–589. https://doi.org/10.1017/S0305000920000537

Kaur, R. (2015). Descriptive Analyses of Phonological Development in Typically Developing Hindi-Speaking Children.

Kehoe, M. (2002). Developing vowel systems as a window to bilingual phonology. *International Journal of Bilingualism, 6*(3), 315–334.

Kehoe, M., & Girardier, J. (2020). Bilingual phonological development: Segmental accuracy and whole-word measures in French and English. Bilingualism: Language and Cognition, 23(4), 770–788. https://doi.org/10.1017/S1366728919000294

Kehoe, M., & Havy, M. (2018). The role of language exposure and vocabulary size in bilingual phonological development. Applied Psycholinguistics, 39(3), 553–580. https://doi.org/10.1017/S0142716417000480

Kehoe, M., & Lleó, C. (2003). The effect of inter-word position on phonological development in German and Spanish bilingual children. Journal of Child Language, 30(4), 867–896. https://doi.org/10.1017/S0305000903005901

Kim, A. Y., Park, A., & Lust, B. (2018). Simultaneous vs. successive bilingualism among preschool-aged children: A study of four-year-old Korean–English bilinguals in the USA. *International Journal of Bilingual Education and Bilingualism*, *21*(2), 164-178.

Kim, J. Y., & Ha, J. W. (2023). In an EFL environment: Characteristics of speech sound disorders in children's English articulation. *Communication Sciences & Disorders*, *28*(4), 837-846.

Kochetov, A., & Sreedevi, N. (2015). Palatography of Kannada affricates: A comparative study. Journal of the Acoustical Society of America, 137(4), EL312–EL317. https://doi.org/10.1121/1.4916798

Kochetov, A., Savariaux, C., Lamalle, L., Noûs, C., & Badin, P. (2020). An MRI-based articulatory characterization of Kannada coronal consonant contrasts.

Kochetov, A., Savariaux, C., Lamalle, L., Noûs, C., & Badin, P. (2023). An MRI-based articulatory analysis of the Kannada dental-retroflex contrast. *Journal of the International Phonetic Association*, *54*(1), 227-263.

Kochetov, A., Sreedevi, N., & Kumaraswamy, B. (2020). Retroflex stops and the dental-retroflex contrast in Kannada: An ultrasound study. Journal of the International Phonetic Association, 50(3), 378–405. https://doi.org/10.1017/S0025100318000452

Li, F., & Munson, B. (2016). The development of voiceless sibilant fricatives in Putonghua-speaking children. *Journal of Speech, Language, and Hearing Research*, *59*(4), 699-712.

Lim, H. W., & Chieng, A. C. J. (2022). English-Malay speech acquisition by children with Indian (Tamil) heritage. *Speech, Language and Hearing*, *25*(3), 364-376.

Lim, V. P. C., & Chieng, F. (2021). Speech sound development of English-Malay bilingual children of Indian heritage. Clinical Linguistics and Phonetics, 35(8), 728–752. https://doi.org/10.1080/02699206.2020.1823039

Maitreyee, R., & Goswami, S. (2009). Language Experience and Proficiency Questionnaire (LEAP-Q): Adaptation for Indian populations. All India Institute of Speech and Hearing.

Maphalala, Z., Pascoe, M., & Smouse, M. R. (2014). Phonological development of first language isiXhosa-speaking children aged 3; 0–6; 0 years: A descriptive cross-sectional study. *Clinical linguistics & phonetics*, *28*(3), 176-194.

Mayr, R., Siddika, A., Morris, J., & Montanari, S. (2021). Bilingual phonological development across generations: Segmental accuracy and error patterns in second-and third-generation British Bengali children. *Journal of Communication Disorders*, *93*, 106140.

McAlister, J., McLeod, S., & Wilson, L. (2022). Speech sound acquisition of Fiji-born children acquiring Fiji English. Clinical Linguistics and Phonetics, 36(10–11), 918–938. https://doi.org/10.1080/02699206.2021.1979397

McLeod, S., & Crowe, K. (2018). Children's consonant acquisition in 27 languages: A cross-linguistic review. American Journal of Speech-Language Pathology, 27(4), 1546–1571. https://doi.org/10.1044/2018_AJSLP-17-0100

McLeod, S., & Crowe, K. (2018). Children's consonant acquisition in 27 languages: A cross-linguistic review. *American journal of speech-language pathology*, *27*(4), 1546-1571.

McLeod, S., & Verdon, S. (2017). The international guide to speech acquisition. Plural Publishing.

Namasivayam, A. K., Li-Han, L. Y., Moore, J. G., Wong, W., & Van Lieshout, P. (2025). The articulatory basis of phonological error patterns in childhood speech sound disorders. *Frontiers in Human Neuroscience*, *19*, 1635096.

Neenu, S., & Sreedevi, N. (2011). Re-validation of Malayalam articulation test (3-4years) [Master's dissertation, University of Mysore] Institutional Repository of All India

Institute of Speech and Hearing. http://203.129.241.86:8080/xmlui/bitstream/handle/123456789/1080/836.pdf

Nip, I. S., Green, J. R., & Marx, D. B. (2011). The co-emergence of cognition, language, and speech motor control in early development: A longitudinal correlation study. *Journal of Communication Disorders*, *44*(2), 149-160.

Niu, R., Chen, Y., & Wu, J. (2023). L2 learners' pronunciation of English phonetic sounds: An acoustic analysis with software Praat. *International Journal of Linguistics, Literature and Culture*, *9*(5), 209-225.

Noiray, A., Popescu, A., Killmer, H., Rubertus, E., Krüger, S., & Hintermeier, L. (2019). Spoken language development and the challenge of skill integration. *Frontiers in Psychology*, *10*, 2777.

Paradis, J., Genesee, F., & Crago, M. (2004). Dual language development and disorders: A handbook on bilingualism and second language learning. Brookes Publishing.

Pearson, B. Z., Fernandez, S. C., & Oller, D. K. (1997). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. Language Learning, 43(1), 93–120. https://doi.org/10.1111/j.1467-1770.1993.tb00174.x

Pham, T. H. T., & Hải, Y. V. T. (2024). A CONTRASTIVE ANALYSIS ON PHONOLOGICAL FEATURES OF ENGLISH AND VIETNAMESE CONSONANT SYSTEMS. *SCIENTIFIC JOURNAL OF TAN TRAO UNIVERSITY*, *10*(6).

Prathima, K. (2009). *Development of articulation test for Kannada speaking children* (Unpublished master's dissertation). University of Mysore, Mysuru, India.

Prathima, S., & Sreedevi, N. (2009). Articulation acquisition in Kannada-speaking urban children: 3–4 years. Journal of the All India Institute of Speech and Hearing, 28, 31–45.

Prusty, V.R., Banik, D.A., &Devi, P. (2022). Standardization of Odia Stimuli for Few Phonological and Morphological Tasks. *International Journal of Health Sciences and Research.* 12(8), 181-193.

Pyata, R., & Banik, A. (2016). Phonological development profile in typically developing Hindi speaking children. *Language in India*, *16*(3), 149-159.

Ranjitha, R., & Sreedevi, N. (2024). Sentence Imitation Task to Understand Phonological Representations in Preschool Children. *International Journal to Health Sciencesand Research.* 14(4), 78-84.

Rhydhm, G., Vivck, S., Trupti, L. B. Shilpi, R., & Irfana, M. (2019). Acquisition of consonant Clusters, /L/ and /R/ in Hindi Speaking Children. Journal of Control & Instrumentation 10(2), 21-24.

Roshini, R., Garibaldi, A., & Venkatesh, L. (2025). Phonetic Inventory and Syllable Structure Types Amongst Typically Developing Children and Late-Talkers Speaking Tamil at 2 Years of Age: A Cross-Sectional Study. *International Journal of Language & Communication Disorders*, *60*(5), e70120.

Ruiz-Felter, R., Cooperson, S. J., Bedore, L. M., & Peña, E. D. (2016). Influence of current input-output and language-learning history on phonological acquisition in early bilingual Spanish-English children. International Journal of Language and Communication Disorders, 51(4), 361–375. https://doi.org/10.1111/1460-6984.12214

Rupela, V., & Manjula, R. (2006). Phonological processes in Kannada-speaking children. Journal of the Indian Speech and Hearing Association, 20, 44–52.

Scarpelli, A., & Core, C. (2015). Cross-linguistic influence in bilingual speech development: A review. Bilingualism: Language and Cognition, 18(4), 620–637. https://doi.org/10.1017/S1366728914000674

Schussler, K. F. (2012). *Working memory processes in children with and without persistent speech sound disorders* (Order No. 3522086). (1039509975). https://www.proquest.com/dissertations-theses/working-memory-processes-children-with-without/docview/1039509975/se-2

Shanbal, J. C., & Prema, K. S. (2007). Language background questionnaire for bilingual children. All India Institute of Speech and Hearing.

Shetty, M. S. J., & Kumaraswamy, S. (2025). Phonological Process in Typical Children Speaking Tulu. *Strength for Today and Bright Hope for Tomorrow Volume 25: 8 August 2025 ISSN 1930-2940*, 24.

Shetty, S. (2015). Speech sound acquisition in Indian languages: A review. *Language in India, 15*(5), 120–135.

Singhi, P., Kumar, M., Malhi, P., & Kumar, R. (2007). Utility of the WHO ten-question screening instrument for disability in a rural population in North India. Journal of Tropical Paediatrics, 53(6), 383–387. https://doi.org/10.1093/tropej/fmm039

Sridhar, S. N. (1990). *Kannada*. Routledge.

SSTP, R. (2022). Abstracts of the 8th International Conference on Speech Motor Control Groningen, August 2022. *Stem- Spraak- en Taalpathologie.*

Stoel-Gammon, C. (1985). Phonetic inventories, 15–24 months: A longitudinal study. Journal of Speech and Hearing Research, 28(4), 505–512. https://doi.org/10.1044/jshr.2804.505

Swapna, N., Prema, K. S., & Geetha, M. L. (2010). Assessment Checklist for Speech-Language Skills. All India Institute of Speech and Hearing.

Tresoldi, M., Barillari, M. R., Ambrogi, F., Sai, E., Barillari, U., Tozzi, E., ... & Schindler, A. (2018). Normative and validation data of an articulation test for Italian-speaking children. *International Journal of Pediatric Otorhinolaryngology*, *110*, 81-86.

van Haaften, L., Diepeveen, S., van den Engel-Hoek, L., de Swart, B., & Maassen, B. (2020). Speech sound development in typically developing 2–7-year-old Dutch-speaking children: A normative cross-sectional study. *International journal of language & communication disorders*, *55*(6), 971-987. https://doi.org/10.1111/1460-6984.12575

Vipina, V., & Sreedevi, N. (2011). Re-validation of Malayalam articulation test (4-5years) [Master's dissertation, University of Mysore] Institutional Repository of All India Institute of Speech and Hearing. http://203.129.241.86:8080/xmlui/bitstream/handle/123456789/1096/851.pdf

Vrinda, R., & Sreedevi, N. (2011). Re-validation of Malayalam articulation test (5-6 years) [Master's dissertation, University of Mysore] Institutional Repository of All India Institute of Speech and Hearing. http://203.129.241.86:8080/xmlui/bitstream/handle/123456789/1097/852.pdf

Wiltshire, C. (2015). Kannada. In S. Fuchs, M. Toda, & M. Zygis (Eds.), *The handbook of speech production* (pp. 1–20). Wile.

Wiltshire, C. R. (2015). Kannada phonology. In M. S. Thirumalai (Ed.), Language in India: Special issue on South Asian languages. https://www.languageinindia.com.

Yadava, T. G., & Jayanna, H. S. (2018). Creation and comparison of language and acoustic models using Kaldi for noisy and enhanced speech data. *International Journal of Intelligent Systems and Applications*, *12*(3), 22.

APPENDIX A

WHO TEN-QUESTIONNAIRE 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)

(To obtain proficiency details of children)

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: Place:

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	

- 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 (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 the participants in the study:

I, Ms. Agraja K, studying MSc in Speech-Language Pathology at All India Institute of Speech and Hearing, Mysuru, is conducting a study titled ***"Speech sound development in typically developing Kannada-English sequential 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 to be a participant in this investigation/study.

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

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