EFFICACY OF PARENT-BASED ARTICULATION INTERVENTION FOR CHILDREN WITH HEARING IMPAIRMENT IN MALAYALAM

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Register No: P01II21S0013

A Dissertation Submitted in Part Fulfilment of Degree of Master of Science

(Speech-Language Pathology)

University of Mysore,

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SEPTEMBER 2022

CERTIFICATE

This is to certify that this dissertation entitled **Efficacy of Parent-based Articulation Intervention for Children with Hearing Impairment in Malayalam** is a bonafide work submitted in part fulfillment for the degree of Master of Science (Speech Language Pathology) of the student with Registration Number P01II21S0013.This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru

September, 2023

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This is to certify that this dissertation entitled **Efficacy of Parent-based Articulation Intervention for Children with Hearing Impairment in Malayalam** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **Efficacy of Parent-based Articulation Intervention for Children with Hearing Impairment in Malayalam** is the result of my own study under the guidance of Dr. N Sreedevi, Professor of Speech Sciences, Department of Speech and Language Sciences, All India Institute of Speech and Hearing, Mysuru, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysore **Registration No: P01II21S0013**

September, 2023

ACKNOWLEDGEMENT

*I want to extend my heartful thanks to **Dr. N Sreedevi** for all the support and guidance from day one. Thank you for patiently clarifying even the most minor queries.*

*I would also like to extend my gratitude to **Prof .M Pushpavathi, Director of AIISH, for allowing me** to carry out this study and for all the help and support throughout my study.*

*I am thankful to **Vasanthalakshmi Mam** for all the help and guidance. Thank you for being so warm and understanding. I would also like to thank **Shijith Kumarsir** and other library staff for all the help and support.*

*I would like to thank my **Parents, brother Jerin and sister Mahima,** for always providing me with opportunities for doing the things I love and enjoy. I hope you guys are always happy.*

I am thankful to all who took the time to participate in the study and helped me with the validation purpose.

*I would like to thank **Joseph** for all the support and help. I really do not know how I would have managed all these things without your help. I am thankful for all the good times and memories. I wish you all the happiness and success in life. Keep smiling always.*

*I would like to thank **Archana and Rhea**, my dissertation partners. I'm glad we all could work together. Moreover, Archana, I will miss out on our small talk. I wish both of you all the best in life.*

*I am thankful to **Sruthi, Kripa, Fathima, Irfana, Namreda, Akhila, and Archana for our good times**.*

*My heartfelt thanks to **Anusmitha Ma'am, Delvin chettan, and Sujisha chechi** for all the help in validating the material. Thank you for always helping me out and being so supportive.*

*I Would also like to thank my senior **Guru, sir,** for the constant push. I wish you all the very best.*

*I am thankful to **Swalih** for being a good friend and person. Thank you for being a part of my college days, and I will miss our early morning hikes.*

*I am indebted to my dear juniors **Sneha, Snitha, Varna, Niveditha, Ashena, Raheba, Chinnu, Niranjana, and Siya** for all the help you have given me. I would also like to thank **Aadarshini and Delcitta** for the help you have done for me.*

Last but not least, I would like to thank my classmates, seniors, juniors, and all other well-wishers for being a wonderful part of this fantastic journey. Let us cross our paths again multiple times in this lifetime. As they say, every end is a new beginning. I wish all of you the very best.

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INTRODUCTION

The term "hearing impairment" refers to a reduction in hearing ability in its broadest definition, ranging from subjectively barely perceptible disturbances to absolute deafness. Hearing loss is a sign of various disorders that damage the auditory organs (Zahnert, 2011). Hearing loss can have a negative impact on several areas of speech, linguistic, developmental, educational, and cognitive outcomes in children if not treated properly. As a result, children with hearing loss have poorer results in speech, language, schooling, social functioning, cognitive capacities, and quality of life (Lieu et al., 2020).

According to the World Health Organization, hearing loss (HL) is the fourth most frequent disability in 2018. According to the 2011 Indian Census, one in every 100 children under six has a disability, amounting to 2.42 million children, 23% of whom have hearing problems. In India, the prevalence of HL in children ranges from 6.6% to 16.47% (Verma et al., 2021). In underdeveloped nations, more than ten children out of every 1,000 live births occur with congenital HL with severe to profound bilateral loss (Pascolini & Smith, 2009).

Children with hearing loss (HI) always tend to have speech sound disorder (SSD). Individual productions of numerous phonemes are accurate in HI children. However, connected speech is difficult, and as a consequence, they have poor speech intelligibility (Svirsky, 2007). Several investigations conducted across time confirm vowel and consonant production errors. Principally, substitution, distortion, and omissions are verified in children with HI (Ambrose et al., 2014; Moeller et al., 2007; Stoel-Gammon, 1988; von Hapsburg & Davis, 2006; Vihman, 1996; Stelmachowicz et al., 2004; Hudgins et al., 1981; Joy, 2020; Sreedevi & Mathew, 2022).

Most phonemes other than vowels and some bilabial stop consonants fall short of

the 90% criterion for children with HI (Banik, 2003). Compared to consonants, vowel production has been reported to be better due to the relative ease in producing vowels in the speech of children with HI (Baudonck et al., 2011; Brannon, 1966; Joy, 2020; Ozbi & Kogovek, 2010). Despite the ease of producing vowels, HI children's speech contains vowel errors (Banik, 2022; Joy, 2020; McCaffrey & Sussman, 1994; Smith, 1975), and vowel errors in children with HI who use cochlear implants have also been reported to vary across word positions (Joy, 2020).

Moeller et al. (2010) investigated the acquisition of consonants in children with HI, finding numerous early-appearing glides, nasals, stops, and mid-level stops. Affricates and fricatives are uncommon in the early stages of development. Wiggin et al. (2013) found that 50% of English-speaking children with HI produce correctly all the consonants by age seven.

In children with HI, omission and substitution are the most harmful to speech intelligibility. (Baudonck et al., 2011; Moeller et al., 2010). According to Penã-Brooks and Hedge (2007), distortion errors impact only one sound feature and tend to influence overall speech intelligibility marginally. Substitution errors occur more in the word-initial position and are substituted by more visible consonants (Baudonck et al., 2011; Law & So, 2006), and manner and voicing errors are seen more than errors in placement of articulation (Smith, 1975; Markides, 1970). Due to their perceptual shortcomings, voicing errors for stops and fricatives are common in children with HI (Ellis, 2009).

In the Indian context, such errors have been established. Earlier studies were on analog hearing aids. However, recently, studies have been attempted on children using cochlear implants and digital hearing aids. Sreedevi & Mathew (2022) investigated a total of seven 3- to 7-year-old monolingual Malayalam-speaking children diagnosed with a spoken-language disorder related to congenital hearing impairment (> 70 dB HL

bilaterally) who used digital Hearing Aids. The short /u/ and long /i:/ were the most often misarticulated vowels. The frequency of misarticulation of short vowels by the participants of the study was /u/ > /o/ > /a/ > /i/ > /e/ > /ə/, and for the long vowels, it was /i:/ > /e:/ > /u:/ > /o:/ > /a:/.

Another study by the same authors, in 2022, on Kannada-speaking children with HI using digital hearing aids, reported that dental place of articulation was most often substituted for alveolar, retroflex, palatal, and velar places of articulation. Based on the manner of articulation, stops were largely substituted for affricates, fricatives, trills, and laterals. Moreover, voicing errors were more seen for stops (/g/, /ɖ/) and affricates (/ʤ/). Place, manner, and voicing errors were more predominant in the medial than in the initial word position.

Similarly, an unpublished study by the same authors in the year 2023 on Kannada-speaking children with HI using digital hearing aids in the age range of 5 to 7 years in comparison to age-matched typical hearing peers reported that front vowels were the most frequent misarticulated vowels and fricatives (/s/, /ʃ/), lateral (/l̪/), affricate (/ʤ/) were the most misarticulated consonants in children with HI. Substitutions were the predominant error type, followed by omissions and distortions. Addition error was insignificant for both vowels and consonants. Fricatives and affricates showed prominent substitution errors in the medial position, while stops and trill were more affected in the initial position. Overall, errors were more seen in the word medial positions than in initial positions for both vowels and consonants. Place errors were more frequent than manner and voicing errors.

Guru, 2022, did a comparative study on Telugu-speaking children with hearing impairment using digital hearing aids and cochlear implants. He reported that the production of vowels and diphthongs was better than consonant sounds. However,

producing short vowels /u/ and /o/ and the long vowel /u:/ was significantly difficult. Substitution of vowel /u/ for the vowel /o/ suggested neutralization to a central vowel and substitution of vowels among the neighboring vowels in the quadrilateral. Based on the place of articulation, bilabial consonant production was better compared to other consonants, and production of the alveolars /s/ and palatal consonants /ʃ/, /tʃ/, /dʒ/ were difficult for the children with HI. Substitution errors were more exhibited, followed by distortion and omission. No addition errors were observed. Place of articulation errors were more when compared to the manner and voicing errors. Among clusters, omission errors were predominantly seen in both initial and medial clusters.

Speech intelligibility in children with HL is crucial for oral communicative competence (Marschark & Spencer, 2005) and social development (Most, 2007). HL during infancy and early childhood contributes to poor speech and language development by restricting a child's access to speech and language input (Tomblin et al., 2014).

Speech intelligibility refers to the perceived clarity of a speaker's speech output that the listener can understand (Pascoe, 2006). It measures the accuracy of the speaker's productions so that listeners can understand them. It results from coordination between the speech subsystems and the precise movement of the articulators.

According to Osberger (1993), speech intelligibility in children with severe to profound HL was only 20% intelligible to judges who were students with no previous exposure of observing a hearing-impaired talker's speech. These low levels of speech intelligibility have led to significant communication barriers in their daily lives (Bat-Chava & Deignan, 2001). Families with these children confront mental anguish, social isolation, and practical problems in raising their children. As a result, families must be prioritized in the delivery of assistance to young children with communication problems. Another reason for the inclusion of caregivers in the rehabilitation process of children is

because they are better aware of their child's strengths and weaknesses, though informally. Second, they have more frequent interactions and spend maximum time with their child; third,they are their ward's natural and first teachers (Girolametto et al., 2001).

Caregiver involvement in the intervention begins with clearing up misconceptions regarding their child's condition or disorder, accompanied by counseling and guidance to overcome their emotional uproar. They are to be educated about necessary interventions so that they can make decisions about their child's rehabilitation. Caregiver empowerment and participation should be integral to intervention measures at any early stages (Shonkoff & Hauser Cram, 1987; Yoshinaga-Itano et al., 1998). Hence, the motivation for the present study stems from the fact that empowering parents of children with HI goes a long way in improving their speech intelligibility.

Need for the study

Children with HI face grave difficulty in articulation and phonological systems, thus resulting in poor speech intelligibility. Improving the speech intelligibility of children with profound HI has become one of the essential goals in rehabilitation. Despite technological advancements such as cochlear implantation and digital hearing aids, speech therapy services are essential to help them overcome their speech unintelligibility.

The trigger for the current study was the observation that many children with hearing impairment who have achieved age-adequate language still show poor speech intelligibility. Speech therapy for children with HI mainly focuses on the mastery of language and underlooks the proficiency these children need in articulation. Preschool services focus primarily on academic teaching and do not address quite as much in the area of speech sound correction for children with HI. Thus, speech intelligibility falls back and continues to be a major obstacle for attaining good verbal skills in children with HI.

Several parental reports state that speech intervention services are at a standstill after preschool and the initial speech therapy services, mainly because of the pressure on families to return to their native places for their child's academic enrollment and other family commitments. In the beginning, most caregivers dedicate a few years, then the provision for attending services is stopped for the reasons stated. They rarely do follow-up and booster sessions. A few years down the road, the children are slowly seen to have issues with academic credentials and poor quality of life because of compromised speech intelligibility. This makes the children with HI depend more on sign language, and the verbal mode of communication is reduced. Services after a point are pretty much complex for most caregivers due to socioeconomic barriers and the loss of dedication they initially had. Therefore, they stop investing in speech therapy. Thus, most children lack the provision to receive refinements in articulation to enhance their speech intelligibility.

Traditional in-person appointments can yield many barriers to patients, limiting their capacity to obtain ongoing care and needed services to improve their speech and language abilities. Most caregivers and their young clients access therapy from places beyond reach. In many cases, after the successful early intervention, they return to their home states that do not have the necessary ongoing support services, which can be a barrier to successful intervention.

With continuous evolvement in technology and global connectivity offered by the internet, a clinician-assisted parent-based articulation intervention via the tele-mode is expected to benefit parents significantly. The need of the present day emphasizes early intervention services, which insist on the caregiver's empowerment in improving the articulation abilities of their children. Caregiver empowerment is a vital intervention component, especially in stages like these. The rehabilitators can promote the transfer of necessary skills and knowledge and mold their attitudes through regular counseling and

guidance sessions. This will equip caregivers with better skill training and allow children to participate better in school activities (Malar et al., 2013). Hence, the present study will empower parents to help their children with HI improve their communication skills with better clarity of speech.

Aim of the study

The present study aimed to examine the efficacy of parent-based articulation intervention via hybrid mode in improving the speech intelligibility of native Malayalam-speaking children with hearing impairment (HI).

Objectives of the study

1. To develop a parent-based articulation training manual for children with hearing impairment in Malayalam.
2. To establish the efficacy of parent-based articulation intervention via hybrid mode in Malayalam-speaking children with HI.

Chapter 2

REVIEW OF LITERATURE

Hearing is one of the fundamental senses connecting us to the world. It allows us to engage in meaningful conversations and be aware of the sounds surrounding us. **Hearing loss affects millions of people worldwide.** The World Health Organization (2021) estimated that globally, more than 1.5 billion people experience some degree of hearing loss. Of these, 430 million people have moderate or higher levels of hearing loss. According to the 2011 Census of India, one in 100 children under six years of age has a disability, corresponding to 2.42 million children, of whom 23% have hearing disabilities. The prevalence of HL for children in India ranges from 6.6% to 16.47% (Verma et al., 2021). Over ten children out of 1,000 live births are born with congenital HL with severe to profound bilateral loss in developing countries (Pascolini & Smith, 2009).

Hearing loss impacts the ability of an individual to perceive sounds and can impact speech production adversely. When individuals experience hearing loss, they often struggle to hear and distinguish certain sounds accurately. This can lead to difficulties in perceiving subtle differences in pronunciation. As a result, their articulation of speech sounds may be affected. However, with the advancement in service delivery and therapeutic interventions, significant progress can be achieved in **mitigating the effects of hearing loss on articulation**. One such intervention that has shown promising results is a parent-based approach (White et al., 1992).

2.1 Acquisition of Speech sounds

Articulation abilities are developed in stages. Native English-speaking children are typically 75% intelligible by age three, 90% by age four, and 100% by age five (Pena-Brooks & Hegde, 2007).

Consonant clusters (CCs) are the last phonetic patterns children learn during their

phonological development (Adi-Bensaid & Ben-David, 2010; Allerton, 1976; Grunwell, 1981; Preisseret al., 1988). Crowe and McLeod (2020) examined the normal age and pattern of English consonant acquisition in children in the United States. According to the study, most consonants were learned by age five. The consonants /b, n, m, p, h, w, d/ were acquired by 2.0-2.11 years, /ɡ, k, f, t, ŋ, j/ by 3.0-3.11 years, /v, ʤ, s, ʧ, l, ʃ, z/ by 4.0-4.11 years, /ɹ, ð, ʒ/ by 5.0-5.11; and /θ/ was acquired by 6.0-6.11 (90% criterion) years. Variation was seen between the studies investigated due to diverse evaluations, criteria, and child cohorts.

A cross-linguistic study across 27 languages also by McLeod and Crowe (2018) reported that children acquired most consonants by five years, all nasals, plosives, and glides by 3.11 years, all affricates by 4.11 years, all liquids by 5.11 years, and all fricatives by 6.11 (90% criterion) years.

Van Haaften et al. (2020) conducted a cross-sectional study to describe the speech-sound development of typically developing Dutch-speaking children from 2 to 7 years. Except for the voiced fricatives (/v/, /z/) and the liquid (/r/), the consonant inventory for syllable-initial consonants was complete by 3.7 years of age. Similarly, all syllable-final consonants were learned before the age of 4.4 years. By the age of 3.4 years, all children had a complete vowel inventory, and by the age of 4.7 years, they could produce the majority of syllable structures properly. The syllable structure CCVCC, on the other hand, was still evolving. At the age of 3.8, all phonological contrasts were appropriately created. Children of lower ages employed more phonological simplification techniques than children of later ages, except for the initially occurring cluster reduction from three to two consonants and the final cluster reduction from two to one consonant, and all cluster errors vanished by the age of 4.4 years.

There are several studies in the Indian context also. Shishira et al. (2010) studied

the development of speech intelligibility in typical Kannada-speaking children. According to the data, normal children reach 85% intelligibility by 3.3 years of age and approximately 100% intelligibility by four years of age. According to Neenu et al. (2011), most consonants, except for fricatives, laterals, and aspirants, were acquired by age 4 in native Malayalam-speaking children.

In the subsequent studies, various investigators have reported the early emergence of medial clusters compared to initial clusters in different Indian languages such as Malayalam (Neenu et al., 2011), Kannada (Deepa & Savithri, 2010; Rupela & Manjula, 2006) and Telugu (Neethipriya & Manjula, 2007; Sneha & Sreedevi, 2012).

Divya and Sreedevi (2010) studied the acquisition of CC in Malayalam in the age range of 2-3 years. They reported that by 2.9 years, children begin to produce clusters but have substitution errors. Medial clusters were acquired earlier than initial clusters. However, by three years of age, the clusters produced were below the 75% criteria. Vrinda and Sreedevi (2011) reported that by the age of six years, 14 out of 15 clusters studied met 90% criteria in initial and medial positions in Malayalam. Also, the common errors found were cluster reduction followed by epenthesis and substitution (Vrinda & Sreedevi, 2011).

Phonotactic development of Kannada-speaking children aged 0 to 5 years was studied by Rupela and Manjula (2006). It was found that medial geminate clusters were observed to be acquired first (12-18 months). CC acquisition was also studied in Kannada (Deepa & Savithri, 2010; Prathima & Sreedevi, 2009), Telugu (Neethiriya & Manjula, 2007; Padmaja, 1988), and Bengali (Banik, 1988).

Although there are discrepancies in phoneme development in the literature, general patterns can be observed. As an example, nasals (/m, n, ŋ/), stops (/p, b, d, t, k, g, ʔ/), and /w/ are typically established prior to fricatives (/f, v, h, ð, s, z, ʃ, ʒ/), affricates (/ʧ,

ʤ/), liquids (/l, r/), and /j/ (Goldman & Fristoe, 2000; Prather et al., 1975; Sander, 1972; Smit et al., 1990; Templin, 1957; Watson & Scukanec, 1997).

2.2 Speech Sound Acquisition in Children with Hearing Loss

Wiggin et al. (2013) investigated consonant development in 269 children aged 15 to 84 months with hearing loss. Samples were collected and analyzed during a 25-minute parent-child interaction. Results indicate the ages at which 50% and 80% of children produced each English consonant. At least 50% of children with mild hearing loss had produced stops, glides, and two of the three nasal consonants by 15 months, and 80% did so by 27 months or earlier. By the time the children were five, 50% could produce every phoneme but /ʒ/. Only /ʧ, ʤ, h, ʃ, ʒ/ were not produced by 80% of the children by the age of six.

At 27 months, 80% or more children with moderate hearing loss could produce every stop phoneme except /g/, all glides, and /n/, /m/, and /h/. By the time they were 48 months old, 80% of the children had expanded their consonant repertoire by adding the sounds /g/, /s/, /l/, and /r/. Only /ʧ/, /ʤ/, /ʃ/, /ʒ/ were not formed by 80% of the children by seven years of age.

The same study reported that by age five, 50% of children with severe degrees of HL could produce all phonemes except for /ð/, /ʤ/, and /ʒ/. At 48 months, there were still 12 consonants that 80% of the children did not produce. Only /n/, /ʧ/, /ʤ/, and /v/ was not yet produced by 80% of the children at seven years of age. Thus, the study revealed that 50% of English-speaking children with HI correctly produced all consonants by age seven, and phoneme development followed a similar pattern to that of children with typical hearing. However, the pace of development of later-developing consonants, on the other hand, is slowed, and the duration of this slowed development rises with the degree of hearing loss. By age 5, children with mild to moderate hearing loss may have few

articulation problems similar to children with normal hearing (Elfenbein et al., 1994).

Similar studies on the analysis of articulatory errors have been conducted in the Indian context. Banik (2003) reported that children with HI took longer to develop all categories of stop sounds, developing /ma/, /ba/, and /pa/ at the ages of 5-6, 6-7, and 7-8 years, respectively. There was also a delay or deviation in consonant cluster acquisition and an inability to differentiate between voiced and voiceless consonants.

Ambrose et al. (2014) compared the speech sound production skills of 2-year-old children with HI to that of children with normal hearing and found that children with hearing impairment showed delayed consonant production skills. However, the consonant development was parallel to that of typically developing children.

2.3 Articulation Errors in Children with Hearing Loss

Children with HL encounter various challenges in communication and language development. One area mainly affected is the production of speech sounds (Rosenbaum, 2016).

Children with severe degrees of HL are prone to have poorer speech production skills due to auditory perception difficulties and reduced ability to identify phonemes effectively (NIH Consensus Statement, 1995; Robbins et al., 1991). The production errors consist of voicing errors, omissions or distortions, and nasalization of phonemes (Hudgins & Numbers, 1942). Due to distortion within the auditory system and insufficient gains offered by hearing aids, people with profound hearing loss are likely to have delayed or disordered speech production, even with amplified hearing (Geers et al., 1984; Levitt et al., 1987; Tomblin et al., 2014).

Articulation errors occur when an individual has difficulty producing specific speech sounds. These errors can be divided into two categories: vowel errors and consonant errors. Vowel errors involve mispronunciation or distortion of vowel sounds,

while consonant errors involve difficulties in producing specific consonant sounds. **Several western (**Ambrose et al., 2014; Moeller et al., 2007; Stoel-Gammon, 1988; von Hapsburg & Davis, 2006; Vihman, 1996; Stelmachowicz et al., 2004) a**s well as Indian studies (**Joy, 2020; Sreedevi & Mathew, 2022; Guru, 2022) **have shed light on how hearing impairment can manifest in speech difficulties.**

2.3.1 Vowel Errors: Children with hearing loss often struggle to produce vowel sounds accurately due to the inability to perceive and discriminate the subtle differences in vowel sounds required for proper articulation. As a result, they may substitute one vowel sound for another or produce distorted versions of the intended vowel sound. These errors can significantly impact the clarity and intelligibility of their speech (Sreedevi & Mathew, 2022).

Regardless of the ease of vowel production, vowel errors such as central vowel neutralization, tense/lax alterations (/i/-/I/, /u/-/U/), substitution between near vowels in the vowel quadrilateral, and inappropriate or diphthongization of monophthongs are predominantly seen in the speech of children with HI (Brannon, 1996; Guru, 2022; Joy, 2020; McCaffrey & Sussman, 1994; Smith, 1975; Sreedevi & Mathew, 2022;). Vowel mistakes in children with HI have been reported to vary across word positions (Joy, 2020). In the word-initial position, addition errors predominate, but substitution errors (particularly with a mid-central vowel /ə/) predominate over word-medial position error types. In children with HI, vowel errors can correlate with impaired speech intelligibility skills (Metz et al., 1990; Monsen, 1978).

2.3.2 Consonant Errors: Similar to vowel errors, children with hearing loss struggle to accurately produce specific consonant sounds (Sreedevi & Mathew, 2022). Consonant sounds require precise articulation, involving the precise coordination of the articulatory organs (e.g., lips, tongue, teeth). Due to hearing loss, children may have

difficulty perceiving and distinguishing between similar consonant sounds, resulting in substitutions, omissions, or distortions.

The consonant inventories of children with hearing impairment are restricted compared to normal hearing children. Many studies have shown that speech sounds with more visible articulatory motions (such as labiodentals) are simpler for hearing-impaired speakers to create because of the enhanced visual input offered, as opposed to sounds like alveolars, which are more hidden in the mouth (Monsen, 1983).

2.3.2.1 Place of Articulation

Numerous investigations have observed substitution errors involving the same point of articulation. According to the place of articulation, correctly articulated consonants were analyzed by Nober (1967), who rated them in descending order from high to low score as bilabials (59%) > labiodentals (48%) > glottals (34%) > linguadentals (32%) > lingua-alveolars (23) > lingua palatal (18%) > lingua alveolars (12%). Smith (1975) and Gold (1980) reported on similar patternsof accurate production; however, these researchers discovered that back sounds were less error-prone than those made in the centre of the mouth. Improved production for more visible phonemes is a typical pattern observed across various word and sentence types (Huntington et al., 1968; Geffner & Freeman, 1980).

Some mid- and later acquired consonants (/l/, /s/, and /z/) are produced more centrally in the mouth and do not offer obvious visual clues. These consonants could take longer to learn than ones with more powerful visual clues (Stoel-Gammon, 1988). Difficulties, such as distortions, substitutes, and omissions, are present during the production of alveolars and palatals (/t, s, z, ʧ, ʤ, θ/) because of the concentration of energy at low-intensity levels and relatively high frequencies (Blamey et al., 2001). Comparable confusions in the perception and production of alveolars, palato-alveolar

phonemes like /t, s, c, and z/ that share similar acoustic-phonetic properties were described by Blamey et al. (2001).

2.3.2.2 Manner of Articulation

The labial stop consonant's strong visibility and simple motoric qualities may account for the relatively early development of the speech of children with HI. Studies on the production of manner features have indicated that fricatives are the least accurately produced, whereas stop consonants are the most accurately produced (Kent, 1992). The sequence of phonemic development indicated that stops come before fricatives, oral sounds before nasal sounds, and anterior sounds before posterior sounds (Peng et al., 2004; Tye-Murray et al., 1995). Smith (1975) reported that bilabial stops, glides, and the fricatives /f/ and /v/ were frequently produced correctly. According to Nober (1967), glides were the most frequently and accurately produced sound, followed by stops, nasals, and fricatives. According to Dillon et al. (2004), the children also tend to delete target sonorants more frequently than target obstruents.

According to Ambrose et al. (2014), There were no differences in bilabial production when normal and hearing-impaired children were compared. However, children with hearing loss performed poorer in alveolar and velar productions. The less extensive visual cues accompanying alveolar and velar places may cause disparities in accuracy between all three sounds, making the alveolar and velar places more difficult than visually noticeable bilabials for children with hearing loss. (Stoel-Gammon, 1988; von Hapsburg & Davis, 2006).

According to Smith (1975), affricates never substituted other consonants but were frequently replaced by one of their portions, typically the plosive part. However, according to Mildner and Liker (2008), fricatives were most frequently used instead of affricates. The fricative /s/ was less accurately produced than other fricatives. Several

researchers have discussed theories as to why the production of /s/ is complex. The auditory qualities of the sounds a child is exposed to directly influence the auditory representation that the child learns (Cristià, 2011).

2.3.2.3 Voicing Errors

One of the crucial components of consonant production is voicing. Reduced capacity to distinguish between voiced and unvoiced consonants may compromise speech understanding (Kent et al., 1989). Usually, voicing contrast acquisition occurs when voiced sounds give space to unvoiced ones (Flege & Eefting, 1986). One of the most typical forms of consonant errors discovered in children using CI was voicing errors (Higgins et al., 2003; Ryalls et al., 2003; Tye-Murray et al., 1995).

Hudgins and Numbers (1942) discovered that errors in voicing were the most common consonant errors. This error has been documented in the following research as occurring to the voiceless cognate (Mangan, 1961; Markides, 1970; Nober, 1967) and, at times, to the voiced member of the pair (Carr, 1953; Millin, 1971; Smith, 1975).

Markides, in 1970, assessed 83 deaf, hard-of-hearing, and partially hearing kids. All the kids were between ages 7 and 9 years. They completed a test of articulation that included 24 pictorially presented monosyllabic words. According to test results, the voiceless cognate was usually substituted when voiced stops were intended.

Mangan's (1961) data can also be interpreted to demonstrate children with hearing impairment's difficulty with voicing contrasts. Both skilled and novice listeners assessed the speech production abilities of 21 deaf and nine hard-of-hearing children as they read a list of known words that are phonetically balanced. This study's participants were reported to devoice final voiced consonants.

Oller et al. (1978) observed that their 6-year-old hearing-impaired individuals omitted, devoiced, or inserted a /a/ after final voiced consonants. They claimed that

avoiding final voiced consonants followed a phonological procedure utilized by younger normal-hearing children.

Nober (1967) used the Templin-Darley Test of Articulation on 46 hard-of-hearing and deaf children aged 3 to 15. He found that intended voiced sounds were less often correctly produced than intended voiceless sounds. Although this is not the same as discovering that voiceless sounds are substituted for voiced sounds, it does suggest that voiced sounds are more difficult to produce.

In contrast to those findings, Smith's (1975) study of 40 severely to profoundly hearing-impaired children reported a reverse tendency of a higher proportion of voiced for voiceless substitutions as opposed to voiceless for voiced substitutions. The children were instructed to read 20 specifically prepared phrases that featured all of English's most frequently used phonemes and transitions to and from the vowels /i/, /ae/, and /u/ at all points of articulation.

Carr (1953) reported a greater tendency to use voiced sounds than their voiceless cognates in a study of spontaneous speech vocalizations of young deaf children aged five years. However, none of these reports indicated whether the voiced sounds were appropriate to the utterance or whether they may have replaced intended voiceless ones. Indeed, Millin (1971) proposed that improper phonation that continues after the finish of a phrase or begins before an utterance is one form of the voiced-voiceless problem (Millin, 1971). This makes all phonemes sound voiced. Despite the high number of voicing errors, there was only a minor association between the number of voicing errors and speech intelligibility in Smith's (1975) study. Hudgins and Numbers (1942) found that voicing errors, consonant blend problems, and removal of the initial consonant all significantly impacted intelligibility. These findings imply that coordination of the articulators required for voicing contrast is highly challenging for the hearing-impaired

speakers.

2.3.2.4 Consonant Cluster Production

The ability to form consonant clusters is one attribute of speech that is clear and understandable. Consonant clusters are groupings of two or more consonants that occur within a syllable and are most commonly seen at the beginning and end of words, such as a plant (/pl ae nt/) (for example, start consonant cluster (/pl/) and final consonant cluster (/nt/).

According to Hudgins and Numbers (1942), cluster mistakes have a critical and detrimental effect on intelligibility. These errors were of two forms: one or more cluster components were lost, or an adventitious phoneme, generally the /ə/, was introduced between the components. Brannon (1966) also discovered that misarticulation of consonant blends was a prominent mistake in hearing-impaired children's speech.

Smith (1975) studied the speech production of older hearing-impaired children (13-15 years old) using consonant blends /p, t, k/, and /s/. The study found that one or more cluster components were frequently omitted. A phoneme was more likely to be omitted in the blended environment than in the non-blend environment.

Joy (2020) analyzed consonant clusters in the initial and medial positions in children with CI, revealing that medial clusters were produced more correctly than initial clusters in Malayalam. The error patterns of consonant clusters observed were similar to the normal cluster acquisition stages in normal children. The most correctly produced cluster type in the initial position was clusters with trills and glides. The predominant error type in the initial position was cluster reduction (Chin & Finnegan, 2000; Dabiri et al., 2019; Flipsen & Parker, 2008), whereas, in the medial position, clusters with nasals scored the highest. The cluster reduction patterns exhibited an inclination towards producing the first consonant of the target cluster in all types of clusters (stop-lateral, stop

trill/flap, stop/fricative-glide clusters) except for fricative-stop/liquid. Ben-David (2001) tested 10 Hebrew children with hearing loss and reported that cluster reduction errors persist for longer in them.

2.4 Indian studies on articulatory characteristics of children using Hearing Aids

Sreedevi and Mathew (2022) studied seven 3- to 7-year-old monolingual Malayalam-speaking children who used digital Hearing Aids and had a spoken-language issue attributable to congenital hearing impairment (> 70 dB HL bilaterally). They observed the commonly misarticulated vowels and consonants in recorded speech samples, in addition to the Malayalam phonemes, that pose a challenge for children with hearing loss. The most often mispronounced vowels were /u/ and /i:/. The order of misarticulation of short vowels by research participants was / > /o/ > /a/ > /i/ > /e/ > /ə/ and for the long vowels, was /i:/ > /e:/ > /u:/ > /o:/ > /a:/.

According to the same study, consonant trills (/r/), affricates (/ʧ/, /ʤ/), and fricatives (/ʂ/, /ʃ/) were most prone to errors. Substitutions caused the most errors. Place and manner errors were more prevalent than other types of errors. More substitution errors occurred in the velar stop's (/k/) initial and medial positions. Its voiced counterpart, /g/, had apparent omissions in the first position and substitution errors in the middle position. The initial word position of the retroflex stop consonant (/ʈ/) and its voiced equivalent (/ɖ/) had more substitution errors than omissions compared to the medial position. The palatal affricate /ʧ/ and its voiced equivalent /ʤ/ substitution errors were more noticeable in the medial position. The most misarticulated consonants were in the decreasing order of /r/ > /ʤ/ > /ʂ/ > /ʧ/ > /ʃ/ > /ɾ/ > /g/ > /s/ >/ɖ/ > /ɭ/ > /ɳ/ > /ʈ/ > /k/. Trills, affricates, and fricatives are misarticulated more frequently than other classes of speech sounds (Eisenberg, 2007; Gordon, 1987; Joy, 2020; Moeller et al., 2010; Wiggin et al., 2013). Substitution and omission errors were more common than other types of

segmental errors (Eisenberg, 2007).

Sreedevi, Anusmitha, and Reshma (2022) researched Kannada-speaking youngsters with hearing loss who used digital hearing aids. According to the study, dental articulatory positions were most frequently substituted for alveolar, retroflex, palatal, and velar places of articulation. Stops were heavily exchanged with affricates, fricatives, trills, and laterals based on the manner of articulation. Furthermore, there were more voicing problems for stops (/g/, /ɖ/) and affricates (/ʤ/). A higher prevalence of place, manner, and voicing errors was seen in the medial than the initial in the word positions.

A comparative study by Guru (2022) of Telugu-speaking children with HI using digital hearing aids and cochlear implants reported that the production of vowels and diphthongs was better compared to consonant sounds, but the production of short vowels /u/ and /o/ and the long vowel /u:/ was significantly difficult. The substitution of vowel /u/ for the vowel /o/ suggested central vowel neutralization and substitution between the neighboring vowels in the quadrilateral. Based on the place of articulation, bilabial consonant production was better compared to other consonants, and production of the alveolars /s/ and palatal consonants /ʃ/, /ʧ/, /ʤ/ were difficult for the children with HI. Substitution errors were more exhibited, followed by distortion and omission. No addition errors were observed. Place of articulation errors were more when compared to the manner and voicing errors. Among cluster errors, cluster deletions were predominantly seen in both initial and medial positions.

Optimal language development appears to occur in the context of daily living and mother-child interactions in a relaxed home setting (Budd et al., 1986; Wulz et al., 1983). Caretakers play a critical role in fostering the infant's participation in communication exchanges and can empathically identify with a child's moods, motivations, and emotional states (Legerstee et al., 2007).

According to Wulz et al. (1983), training in the home environment promotes spontaneous language development. Language learning in an unfamiliar situation is less likely to generalize to different settings. As a result, it is reasonable that intervention for children with speech and language impairments should include therapy delivered in a familiar home setting.

2.5 Parent-based intervention for children with Communication Disorders

Increasingly, parents are being involved more intensively in early intervention. They are trained to work directly with their children and take over the primary, direct service involvement (Weiner & Koppelman, 1987). Several studies have allegedly shown that speech-language pathologists can train parents to function effectively with their children (Arnold et al., 1986; Burnet et al., 1988; Hatten & Hatten, 1971; Levinstein & Sunley, 1967; McDonald et al., 1974; Miller, 1983; Seitz & Reidell, 1974). However, many early intervention programs involve parents less intensely by providing them with supplemental parent programs to change parental interaction styles (Budd et al., 1986). Surprisingly, programs in which parents were only marginally active in their child's intervention were also successful in terms of the child's growth (Karnes. Hodgins. Stoneburner, Studley, and Teska, I968).

Oono et al. (2013) did a systematic review to evaluate the efficacy of parent-mediated early intervention regarding benefits for children with ASD and their parents. Positive changes in parent-child interaction patterns, child language understanding, and reduced severity of the kid's autistic symptoms were reported. However, the study found no statistical evidence of improvements from parent-mediated interventions in most key outcomes examined.

Buschmann et al. (2008) assessed the efficacy of a brief, highly structured parent-based language intervention group program for 2-year-old children with specific

expressive language delay. The control and intervention groups were pre- and post-tested using a German parent-report screening questionnaire. Mothers took part in the three-month Heidelberg Parent-based Language Intervention (HPLI). The children were reassessed six and twelve months after the pre-test. According to the study, 75% of youngsters in the intervention group demonstrated normal expressive language ability, compared to 44% in the control group.

Lawler et al. (2013) conducted a comprehensive review to determine whether speech therapy offered by caretakers improves patient outcomes. The meta-analysis provided high-quality evidence when caregiver-administered speech and language therapy was compared with no intervention condition. However, moderate-quality evidence was found, indicating that therapy offered by speech and language therapists was not superior to therapy administered by caretakers for children with speech deficits.

Cordier et al. (2016) assessed the effectiveness of a parent-delivered play-based intervention supported by occupational therapists and speech-language pathologists in improving the pragmatic language abilities of 9 children with ADHD and nine typically developing peers. The seven-week intervention was administered at home by parents of ADHD children and comprised weekly assigned home-based modules, assisted play-dates between the pairs of children, and three clinic visits. The adherence of parents to intervention activity was tracked weekly. The Pragmatic Observation Measure (POM) was used to monitor peer-peer play interactions before and after the intervention to detect any changes in pragmatic language. The study found that pre-follow-up for both ADHD and typically developing children, as well as pre-post for ADHD children, resulted in significant increases in observed pragmatic language abilities.

2.6.1 Parent-based intervention for children with Hearing Impairment

Giallini et al., 2021 conducted a systematic review on the efficacy of Parent Training (PT) and coaching in deaf and hard of hearing (DHH) therapy programs to evaluate parent sensitivity responsiveness and DHH child language development. The results appear promising in enhancing parent responsiveness and promoting DHH child language development.

Harrigan and Nikoloupolus (2002) conducted before and after research with 17 parents using the Hannen program. A video analysis of the number of parent initiatives and replies was used as the end measure. A comparison of the pre-post count revealed a significant increase in parent responsiveness after the program.

Nicastri et al. (2020) also employed the Hanen program with 22 parents to target language delays in 14 children with severe to profound hearing loss fitted with cochlear implants. The quality of parent interactions was evaluated using a video-recorded sample, and a substantial difference in caretaker behaviours and high scores on all tests administered to children of parents who attended the parent training was noted.

Similarly, Roberts (2019) showed a more considerable improvement in the children of parents who attended parent training. The effects of a parent-implemented communication treatment targeting prelinguistic communication abilities in infants and toddlers with hearing loss were tested in a pilot trial. Compared to the control group, children demonstrated statistically significant gains with a substantial effect size in speech prelinguistic skills.

2.7.2 Parent-based Articulation Interventions

According to surveys of paediatric speech and language therapists (SLTs), children with SSD account for more than 40% of clinicians' caseloads, with over 40,000 children referred in the UK each year (Broomfield & Dodd, 2004; Joffe & Pring, 2008). This rise is also visible worldwide, with SLTs in Australia, the United States, and the

Netherlands reporting that children with SSD account for about half of the average caseload (McLeod & Baker, 2014; Brumbaugh & Smit, 2013; Priester et al., 2009). These children suffer more significant risks of literacy challenges, bullying, and future economic and occupational potential limitations if prompt and appropriate assistance is not provided (McCormack et al. 2009, 2011).

Articulation disorder refers to difficulty in the motor production part of speech (Elbert & Giruet, 1986). These are more consistent than when compared to phonological disorders. Over the years, several approaches have been developed to target these. Studies have shown that children who have plateaued with traditional articulation approaches benefit more regarding intelligibility when using parent-based intervention.

Parent-based articulation intervention involves parents actively facilitating their child's speech and language development, mainly focusing on articulation skills. It emphasizes using everyday activities and interactions to create a rich environment for the child so that articulation intervention can be embedded seamlessly into the child's daily routine, making it more effective and sustainable. Unlike traditional therapy, which relies solely on the expertise of speech-language pathologists, parent-based intervention actively engages parents in the intervention process. They can facilitate frequent repetitions, consistent practice, and generalization of target speech sounds, all in a supportive and communicative environment.

Eiserman et al. (1990) conducted a study that compared the effectiveness of two programs for speech-disordered preschoolers: a home parent training program and a clinic-based program with little parent engagement. Demonstrating sound placement, auditory training for sound discrimination, sound practice in isolation and nonsense syllables, sound rehearsal in single-word production, short phrases, sentences, and prolonged speech were all part of the phonetic approach. With the phonological approach,

the relationships between sounds and language were examined. Rather than addressing each misarticulated sound individually, the kid's speech was studied for patterns of faults, and the child was taught to contrast the wrongly used feature with the proper feature. On measures of speech and language functioning and overall development, children in the home parent training group performed at least as well as those in the clinic-based group, according to post-test data. On several of these criteria, the home parent training group outperformed the other group significantly.

The one-year follow-up test's results correlated with those obtained immediately after the intervention. However, the home parent training group outperformed the other group significantly in several of these factors, such as personal/social skills and adaptable behaviour. This means that parents could be assigned substantial roles in speech intervention. They must, however, be adequately trained by the speech-language pathologists.

Sommers et al. (1959) investigated the effectiveness of educating parents to assist children with functional articulation problems at home. The speech-language pathologist evaluated everyone on all ten sounds, [r], [l], [s], [f], [v], [k], [g], [ʧ], [ʃ], and [θ] and each sound appearing in the initial, medial, and final positions using images of objects. SODA errors were documented. The trial included three stages of articulation testing: one pre-test and two post-tests. Pre-test was performed immediately before the 3.5-week clinical session. The first post-test was performed immediately following the clinical phase, and the second was done nine weeks after post-I. A professional speech-language pathologist provided speech therapy for four consecutive days weekly for three and a half weeks, with one-hour courses. There were games and activities, as well as a phonetic-placement technique. The speech-language pathologists used mirrors, auditory and visual aids, and notebooks. At the conclusion of the clinical training, parents were given a

questionnaire that inquired about their attitudes towards the program and their estimation of the benefits their children obtained from participating in the program. The data in this study show that training parents and children with functional articulation issues simultaneously may result in faster articulation improvement.

Sugden et al. (2016) conducted a systematic review study on the involvement of parents in intervening with children with speech sound disorders. A review of 61 of the 176 publications showed an involvement of parents and home tasks within the intervention. Production practice during set tasks, listening tasks, production practice during everyday conversational speech, parental tasks (e.g., data collection) (e.g., Baker & McLeod, 2004), naturalistic activities (e.g., speech sound stimulation during bath time), self-evaluation or self-monitoring tasks, conceptual tasks (e.g., sorting by initial sound) and other tasks (e.g., shared book reading) were all examples of home tasks. However, the research provided only a few details about the various practices employed in the study.

Broen and Westman (1990) evaluated 20 children aged 4 to 5, 12 in the experimental group and 8 in the comparison group. Up to 17 weekly training sessions of one hour in length were provided. According to the study, parent-delivered intervention was more successful than nothing being done.

Lancaster et al. (2010) investigated the efficacy of SLT-delivered intervention against intervention administered by parents. Parents were given homework assignments to complete with their children and were required to attend treatment sessions. According to the study, parent-delivered intervention was adequate but less effective than SLT-delivered intervention.

2.8 Intervention studies via tele-mode

Telepractice is services delivered remotely using videoconferencing or other technology (American Speech-Language-Hearing Association [ASHA], n.d.).

Telepractice has emerged as another means of delivering services, enabling speech-language pathologists (SLPs) to provide adequate services to individuals with communication disorders and delays (ASHA, n.d.; Cason et al., 2012; Keck & Doarn, 2014; McCarthy, 2013) because videoconferencing technology has developed rapidly in recent decades and access to the internet has become increasingly available (U.S. Department of Commerce, 2013). Telepractice has been advocated to overcome obstacles associated with in-home or clinic-based care. These advantages include reduced travel costs and time and the ability to reschedule canceled or missed appointments (Anderson et al., 2014; Cason et al., 2012; Gibson et al., 2010).

The latest pandemic emphasizes the importance of readily available programs. One strategy for increasing access is to use programs combining videos and digital media in asynchronous content (i.e., content is offered for parents to complete independently), which is cost-effective and may result in favorable outcomes (Andersson, 2018).

SLPs can also provide educational content to parents by combining asynchronous and synchronous features. For example, an SLP may videoconference with the family to deliver the strategy's basic steps and demonstrate how they could use it. Then, the SLP may ask the parents to review demonstrations of the target strategy online asynchronously to illustrate its use and then videoconference to practice the strategy. Parent training can also be delivered in person (e.g., Meadan et al., 2014) or via in-person and telepractice sessions (e.g., Baharav & Reiser, 2010).

According to Grogan-Johnson et al. (2010), school-age children with articulation, language, and fluency problems exhibited comparable progress using telepractice or traditional side-by-side speech-language intervention. In a further study (Grogan-Johnson et al., 2011), 13 school-age adolescents were given speech sound intervention using computer-based speech sound intervention materials delivered by telepractice or

traditional side-by-side intervention. Students in both service delivery models improved their speech sound output significantly.

Akemoglu et al., 2020 conducted a thorough literature review on telepractice and parent-implemented language and communication therapies. Twelve research were reviewed, and all of them found that telepractice-based parent-implemented interventions improved child outcomes.

2.9 Methods for parent training

Due to financial constraints, insufficiently trained professionals serve the expanding number of children eligible for early intervention services (Cason et al. 2012). Rural areas may have a shortage of qualified employees (Cason, 2009). The detrimental impact is exacerbated because rural families lack access to healthcare, particularly health promotion and prevention services.

Van Eerdenbrugh et al. (2017) created the Internet-LP, a variant of the Lidcombe Programme for Early Stuttering—six of the eight parents of toddlers who stammer completed the experiment. Post-trial evaluations revealed that a fully asynchronous, internet-based stuttering intervention may be beneficial for instructing parents about stuttering identification, knowledge about conducting practice sessions, and how to present intervention strategies as part of the Lidcombe Programme.

Van Balkom et al. (2010) conducted a pre-post comparison of Parent Video Home Training, which used videos as a dominating training component, on 11 parents of children aged 2 to 3 years. The group that received the Parent Video Home Training intervention saw more significant gains in child outcome indicators.

Bellon-Harn et al. (2020) conducted a meta-analysis to assess the use of videos and digital media in parent-implemented therapies for parents of children with primary language or speech sound disorders. The ten studies chosen included parent-child dyads

ranging in age from 11 months to 10 years. Three of the ten studies included no control groups. Four investigations (Allen & Marshall, 2011; Girolametto et al., 1996; Pratt et al., 2015; Roberts & Kaiser, 2012) were employed that used a pre-post-test design with random assignment to a treatment or non-treatment control group. Baxendale and Hesketh (2003) employed a pre-post-test to assign participants to either a parent-implemented or a direct child intervention based on location. Videos were used by parents to observe and formally analyze how they interact with their children (Allen & Marshall, 2011; Falkus et al., 2016) to provide immediate feedback and coaching (Girolametto et al., 1996; Baxendale & Hesketh, 2003; Konza et al., 2010; Wake et al., 2011), and to introduce new topics and to provide examples of target strategies (Roberts & Kaiser, 2012; Pratt el al., 2015). The interventions generally employed videos with varied amounts of direct support rather than simply asynchronous instructional content. Increased interactions (Konza et al., 2010), significant changes in MLU (Allen & Marshall, 2011; Faulkus et al., 2016), larger overall vocabularies (Girolametto et al., 1996; Roberts & Kaiser, 2012), and changes in children's print knowledge skills (Pratt et al., 2015) were reported as child outcomes from the studies.

Olson et al. (2016) investigated the feasibility of using text messaging to give developmental education to families using a one-group pre-post-test methodology. Parents of children with language issues aged 11 to 36 months were engaged in a 3-month text messaging program. There was an increase in awareness of language-promoting activities and local child development resources, as well as greater engagement in language-promoting activities and self-reported knowledge, according to pre- and post-program telephone surveys. All the parents said they liked the program and would suggest it to other families; 96% thought it benefited their family, and 89% said it helped their child. The results of this pilot project show that text messaging is a viable, engaging, and

cost-effective platform for delivering developmental instruction to families.

Kaminski et al. (2008) used active learning tactics such as cartoons, real-life footage of carers and their children, and brainstorming or problem-solving activities in their study. Furthermore, the authors presented and directly practiced specific listening or communication skills, role-playing, video analysis, video feedback, or direct feedback on shared communication strategies to parents during parent-child interactions. As a result, active learning is promoted more than passive learning approaches.

To summarize literature reports, substantial improvements with parent-based articulation intervention are well reported in individuals with speech sound disorders. However, few studies on the Hearing-impaired population also have shown the benefits of a parent-based articulation intervention in Indian languages. Such research is crucial from a theoretical and clinical perspective because it can provide insight into correcting articulatory errors using a parent-based approach. Hence, the current study aims to examine the efficacy of parent-based articulation intervention in Malayalam-speaking children with HI.

Chapter 3

METHOD

The primary aim of the present study was to establish the efficacy of the parent-based articulation intervention and to develop a parent-based articulation intervention manual for children with HI in Malayalam.

Participants

The study recruited two groups of participants. Group 1 included 7 Malayalam-speaking children with HI in the age range of 5-10 years. They were recruited from the Department of Special Education and The Department of Clinical Sciences at the All-India Institute of Speech and Hearing, Mysore, India. Group 2 included parents of the Malayalam-speaking children with HI participating in Group 1.

In the present study, Group 1 participants underwent articulatory training given by their parents. The researcher provided group 2 (caregivers/parents) the required training through a hybrid mode (offline and online modes) to correct the articulatory errors in their children with HL.

Participant Selection Criteria

Inclusion Criteria for Group-1.

1. Native speakers and reared in an ambient environment of Malayalam.
2. Provisionally diagnosed as congenital sensorineural HL by an audiologist.
3. Moderate to severe degree of sensorineural HL with a speech intelligibility score of $\leq$60%.
4. Fitted with suitable Digital hearing aids based on the configuration of the HL as certified by an audiologist.
5. Undergone a minimum of two years of speech therapy at the time of participation in the study.

6. Uses 2–3-word sentences and has an expressive vocabulary of a minimum of 50-70 words, assessed using the Assessment Checklist for Speech and Language Skills – ACSLS (Swapna et al., 2015).
7. Absence of any co-morbid syndromic conditions such as orosensory, motor, intellectual, neurological, or visual deficits.

Inclusion Criteria for Group 2.

1. Native speakers of Malayalam.
2. Minimum education qualification of 10^{th} grade with knowledge of reading and writing in Malayalam.
3. Possession of a smartphone/laptop system with an internet connection and adequate knowledge to participate in online sessions provided by the researcher.

Research Design

The present study is a one-group pre-test post-test design to analyze the articulation of children with HI before and after the parent-based articulation intervention.

Articulation Outcome Measures

The following three articulation outcome measures were analyzed in the present study.

1. SODA errors analysis
2. Proportion of Whole-Word Correctness (PWC)
3. Percentage of Speech intelligibility

Malayalam Diagnostic Articulation Test-Revised (MAT-R) and a stimulus for story narration were used to assess the child during the online, audio-recorded assessment. The above outcome measures were extracted and analyzed from the recorded speech sample of the assessment.

1. SODA error analysis

Substitution, omission, distortion, and addition errors were extracted from the recorded sample of MAT-R (Neenu et al., 2011). The participants were shown pictures of the target words from MAT-R at a time as a PowerPoint presentation and were asked to name them. If the children found it difficult to name, "repeat after me" mode was used, wherein the participant's parents or caregivers were asked to present the words verbally to the child. After keenly listening, the child was asked to repeat the same. The recorded online sample was documented for later articulatory analysis.

2. Proportion of Whole-Word Correctness (PWC) (Ingram, 2002)

All the words from the single-word elicitation task of MAT-R were considered to obtain the Proportion of Whole-Word Correctness. If all the phonemes in the stimulus word were correct, a score of one was given. PWC was calculated using the following formula:

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

***3.* Percentage of Speech intelligibility**

A storytelling task was employed to calculate speech intelligibility. During the assessment, the researcher initially narrated the selected story of the "Thirsty Crow," the participants were asked to retell the same. To calculate speech intelligibility, the audio recording of the story narration samples was presented to three speech-language on an individual basis, who were proficient in Malayalam and unfamiliar with the participants. The evaluators were asked to write down the words that were intelligible to them, and the researcher calculated the percentage of speech intelligibility using the given formula:

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

Test materials used

The following test materials were used for the online assessment of Group-1 participants for obtaining the pre-test and post-test samples:

1. ***Malayalam Diagnostic Articulation Test-Revised (MAT-R)***

100 Picture stimuli from MAT-R (Neenu et al., 2011) were used to identify the SODA errors and to assess the Proportion of Whole-Word Correctness (PWC).

2. ***Stimulus for story narration***

Picture sequence of the familiar story ***"Thirsty Crow"*** was used as a stimulus and presented in a PowerPoint format. The narration samples of the participants were obtained to calculate the speech intelligibility of the participants.

Instrumentation

Assessment data was collected in tele-mode using WhatsApp video call, and the sessions were recorded with the parent's consent. The bandwidth requirement for WhatsApp ranges from 400 kbps to 1.0 Mbps (ISHA, 2019). The parents and participants were instructed to log in on their mobile phones or laptop computers. The researcher used a laptop computer system (HP) to log in to maintain uniformity of the articulatory assessment. For parents who were in-station, the assessments of the children were carried out on-site (4 participants). However, for those who were not in-station, their children's recordings were carried out through an online mode (3 participants). The audio pre-test and post-test samples were edited on "InShot Video Editor and Maker app" (version 1.890.1391) to extract 10% of the story narration sample. That was further used for obtaining the inter and intra-judge reliability of the speech intelligibility score.

Procedure

The present study was carried out in 3 phases.

Phase 1: Preparation of a parent-based articulation training manual in Malayalam

Phase 2: Content validation of the prepared manual (M-PAC)

Phase 3: Administration of M-PAC to establish its efficacy

Figure 3.1 represents the flow chart of the study.

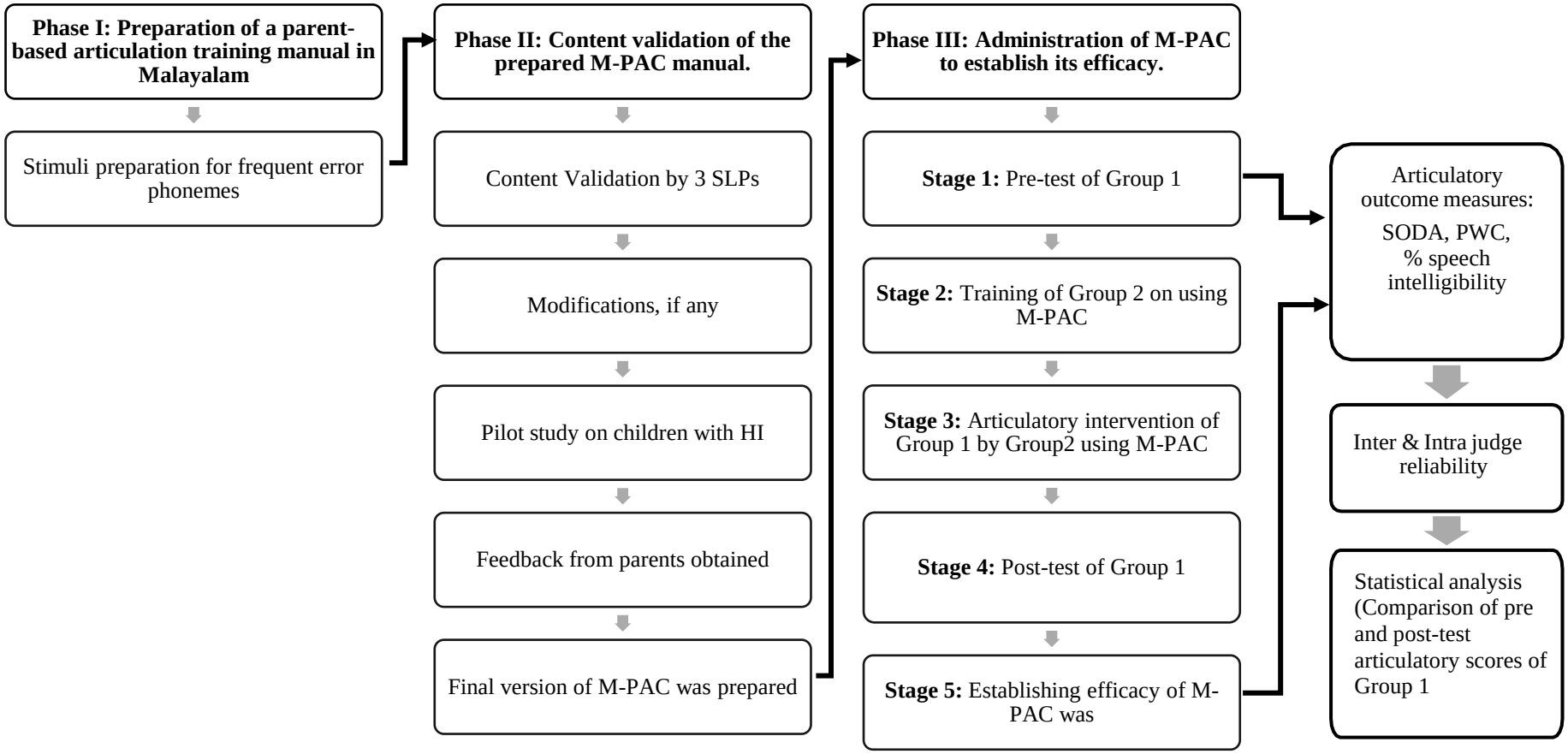

Figure 3.1

Flowchart of the method of the study

Phase 1: Preparation of a parent-based articulation training manual in Malayalam.

Source of Information. The researcher referred to recent articulatory studies documenting the frequent articulatory error sounds seen in children with HI in Malayalam. (Joy, 2020; Sreedevi & Mathew, 2022). The study considered error phonemes documented across these contemporary studies that included vowels and consonants for articulation correction in Malayalam-speaking HI children. The materials for articulation training also included some of the frequently occurring cluster sounds in Malayalam. The researcher collected frequently used words of Malayalam from an online Malayalam dictionary (*Vanmaram*, n.d.). Loan English words in Malayalam and a few activities were adapted from textbooks (Worthley, 1981; Augusta Speech and Hearing Center, 1966; Pena-Brooks & Hegde, 2007). Videos demonstrating how distinct speech sounds were produced regarding their place, manner, and voicing features were sourced (GlossikaPhonics, 2015). Different activities aimed at addressing articulatory errors were adapted from various online platforms to construct tasks for the manual (*Teachers Pay Teachers*, 2006; *The Best English Short Stories for Students | StoryWeaver*, n.d.). Images of selected stimuli words were obtained, and care was taken to make them colorful, engaging, unambiguous, and appropriate for the Indian context.

The researcher also compiled suitable materials for articulation intervention from multiple sources available in Malayalam to prepare the manual, and this consisted of suitable words and picture stimuli from the "Minimal pair-based intervention manual in Malayalam" (Rofina, 2015, pp. 61 -127), the "Articulation drill book for Cleft Palate Population in Malayalam" (Wishly, 2011, pp. 25 - 100),

and from the intervention materials developed as part of a SERB project (Sreedevi et al., 2020).

Organization of Information. The newly prepared manual M-PAC considered 51 Malayalam speech sounds for correction, including ten vowels, 13 consonants, and 28 frequently occurring clusters in Malayalam. Table 3.1 provides the details of the sounds included in M-PAC.

Table 3.1

Shows the details of the sounds included in M-PAC.

Vowels	Consonants	Consonant Clusters
	Voiced and unvoiced velar stops - /g/, /k/	/nʈ/, /nt/, /nʤ/,
	Voiced and unvoiced palatal affricates - /ʤ/, /ʧ/	/nɖ/, /ŋg/, /l̪j/,
Short vowels	Voiced and unvoiced retroflex stops - /ɖ/, /ʈ/	/ʈj/, /mb/, /kj/,
- /a/, /i/, /e/,	Alveolar fricative - /s/	/sk/, /gl/, /tr/,
/u/, /o/	Retroflex fricative - /ʂ/	/pl/, /sl/, /bl/,
Long vowels	Palatal fricative - /ʃ/	/st^{h}/, /nɖr/,
- /a:/, /i:/, /e:/,	Alveolar flap - /ɾ/	/sk/, /sʈ/, /sp/,
/u:/, /o:/	Retroflex trill - /r/	/br/, /ʂr/, /ʈr/,
	Retroflex nasal - /ɳ/	/pr/, /kl/, /gr/,
	Retroflex lateral - /ɭ/	/ʃv/, /kɾ/

The content of M-PAC is organized as follows.

- Introduction to the (long and short) vowels of Malayalam.
- Practice materials containing suitable stimuli words and their pictures to train ten vowels.
- Introduction to the voiced and unvoiced consonants of Malayalam.
- Worksheet for the progress monitoring logbook.
- Brief description of the target phoneme's place, manner, and voicing features with picture and video support to describe the production of each sound.

- Practice materials for 13 consonants in initial, medial, and final positions and in isolation, word, and sentence levels as per the phonotactics of Malayalam.
- Suitable stimuli words and their pictures to train 28 clusters.

Primarily, picture-based activities with naming tasks were used in the manual, where children had to name the pictures shown to them. After every activity the child performs, a visual reinforcement is given. The parents also had the liberty to provide appropriate reinforcements to the child.

Additional Resources included:

- Story sequence images for picture narration activities.
- Illustrations for picture description activities
- Description of different games and activity suggestions for the parents.

Prepared tasks for each phoneme were compiled and presented in a PowerPoint format for ease of presentation and practice. Care was taken to maintain simple, clear, and direct language in preparing the material, and the newly developed manual was named "***M-PAC - Manual for Parent-Based Articulation Intervention for Children.***" The sample of the manual in picture form for one consonant is provided in Appendix 1. A CD including the audio-video files is also enclosed along with the dissertation.

Phase 2: Content validation of the manual (M- PAC).

M-PAC was presented to speech-language pathologists and the parents of children with HI for content validation. Three practicing speech-language pathologists proficient in Malayalam and familiar with intervening children with HI served as judges for validation. They were required to rate the developed material based on the selected rating parameters taken from the feedback questionnaire for Aphasia Treatment Manuals (Goswami et al., 2010).

Following the qualitative analysis of the picture stimuli of the manual by the judges, a few changes were incorporated as per the suggestions:

- Quality and arrangement of the picture stimuli were improved.
- Picture stimuli were made more colorful and attractive.
- Less iconic pictures were replaced with more culturally acceptable stimuli.
- Uniformity in the picture's size was maintained.

These suggested modifications were considered and incorporated into the manual.

Pilot study on children with HI. As part of validating the material, a pilot study was also done. This aimed to get parent's feedback regarding the manual's implementation. For the pilot study, two participants were selected based on the inclusion criteria for Group 1, as cited earlier. They were trained by parents using activities for vowels and /k/. Parents were required to provide feedback regarding the ease of usage of M-PAC to the researcher. The researcher considered the challenges faced during the procedure, and apt changes were incorporated into the manual.

Phase 3: Administration of M-PAC to establish its efficacy.

Four stages are involved in Phase 3:

Stage 1: Pre-test of Group 1 (seven selected participants of children with HI).

Stage 2: Training Group 2 (the parents of the seven children with HI enrolled for articulation intervention) using M-PAC by the researcher.

Stage 3: Articulation training of Group-1 by Group-2.

Stage 4: Post-test of Group 1.

Stage 5: Establishing the efficacy of parent-based articulation intervention for children with HI (pre-test vs. post-test scores).

Stage 1: Pre-test of Group 1. The researcher performed the pre-test individually on the seven HI participants through a hybrid mode (four offline and three

online) with the assistance of their parents in order to obtain the three articulation outcome measures. Such as,

- SODA errors
- Proportion of Whole-Word Correctness (PWC), and
- Percentage of speech intelligibility

The scores obtained were documented for further statistical comparison.

Stage 2: Training of Group 2 using M-PAC. Group 2 was trained on articulatory correction of their children using M-PAC by the researcher. The researcher provided Group–2 participants (parents) four training sessions for correct vowel, consonant, and cluster productions. Training sessions for the parents were conducted in a hybrid mode (four participants offline and three participants on online mode) at their convenience, and active participation of at least one parent or caregiver was made compulsory throughout the procedure. Articulatory activities for a total of 51 phonemes in Malayalam, including ten vowels, 13 consonants, and 28 clusters of Malayalam, were included in M-PAC for articulation correction. Training sessions provided by the researcher were of a 1-hour duration, and each session focused on training the parents (Group 2) on four to five phonemes of Malayalam.

- The first session was to train the parents on the correct productions of 10 vowels and four consonants -velars (/k/, /g/) and affricates (/ʧ/, /ʤ/).
- The second session focused on training them the correct productions of 5 consonants – retroflex stops (/ʈ/, /ɖ/), nasals (/ɲ/), trills (/ɾ/), and fricatives (/s/).
- The third session targeted training the correct productions of 4 consonants – fricatives (/ʂ/, /ʃ/) and laterals (/ɭ/, /ɽ/).
- Finally, the fourth session was for training the parents on the correct production of 28 common clusters in Malayalam.

The researcher was in touch with Group 2 to answer any queries about the procedures involved in the articulation intervention for their children.

Stage 3: Articulation training of Group-1 by Group-2. Depending on the child's errors noted during the pre-test assessment, the researcher informed the parents to train their children on the error sounds. The protocol provided to the parents for training their child for the home-based articulation intervention is given below.

- Parents were asked to work on correcting five phonemes of their children using M-PAC in a span of 1 week.
- Group 2 participants had to maintain a progress monitoring log book documenting which phoneme or phonemes they trained on a particular day and the number of correct productions of the trained phonemes produced by the children. The format of the log book is provided in Appendix 2.
- The children with HI were intervened by their parents independently, and the researcher was not involved in training.
- The clinician monitored the initial two sessions to ensure the parents used the correct procedure.
- The researcher was in touch with the parents during the training period, and they were free to clarify any doubts about the intervention methods. They could contact the researcher when they had difficulty in carrying out the program.

Stage 4: Post-test of Group 1. The articulation outcome measures (SODA errors analysis, Proportion of Whole-Word Correctness (PWC), and Percentage of speech intelligibility) were audio recorded and analyzed after four weeks of parent-based articulation training using the same test materials (MAT-R and the story

stimulus) as the pre-test. The results were recorded for additional statistical analysis.

Stage 5: Establishing the efficacy of parent-based articulation intervention for children with HI. To establish M-PAC's efficacy, appropriate statistical tests were applied to compare the pre-test and post-test scores of Group 1.

Intra-judge and Inter-judge Reliability

Inter-judge reliability was obtained by analyzing 10% of the audio-recorded story narration sample of each of the seven participants during the pre-test and post-test by three experienced speech-language pathologists. Similarly, intra-judge reliability was done using 10% of the same sample obtained during the post-test. The researcher herself carried out it to ensure the reliability of the articulatory analysis of the data. The evaluators had to listen to the story narration sample and do the verbatim translation of each participant. The researcher then matched the translation with the actual story narration sample, counted the number of correctly identified words, and calculated each participant’s speech intelligibility scores using the formula.

Chapter 4

RESULTS AND DISCUSSION

The present study primarily aimed to develop a manual in Malayalam for parent-based articulation intervention to train children with hearing impairment and establish the training's efficacy. The efficacy of a parent-based articulation intervention was established by comparing the pre-post-test articulatory outcome measures of Group 1 participants (children with HI). The study was conducted in three phases. Phase 1 was the preparation of the parent-based articulation training manual in Malayalam (M-PAC). In the second phase, the manual was developed and content validated. The third phase involved administering the M-PAC to establish its efficacy; this was carried out in 5 stages. The first stage involved the pre-test of Group 1 participants. Stage two was training Group 2 (parents of children with HI) using M-PAC by the researcher. Stage 3 was articulatory training of Group 1 by Group 2 for four weeks. In the fourth stage, a post-test of Group 1 was taken. Finally, in the fifth stage, pre-and post-tests were compared to establish the efficacy of parent-based articulation intervention using M-PAC.

The results are discussed under the following headings:

- **Development of a parent-based articulation training manual for children with HI in Malayalam**
- **Establishing the efficacy of parent-based articulation intervention for children with HI.**

4.1 Development of a parent-based articulation training manual for children with HI in Malayalam

A parent-based articulation intervention manual in Malayalam was prepared to achieve the study's first objective in phase one. The manual included ten vowels, 13

consonants, and 28 Malayalam clusters frequently errored in children with HI. The articulatory correction of these phonemes was targeted using fun-based activities and drilling activities in Malayalam with visual reinforcements after every task.

Content validation of the manual in Malayalam.

Three experienced speech-language pathologists served as judges for the content validation of "Manual for Parent Based Articulation Correction." The judges were required to validate the manual using relevant parameters selected from the feedback questionnaire developed for the Aphasia Treatment Manuals (Goswami et al., 2010).

The suggestions from the judges were incorporated, and the manual was modified appropriately. The same speech judges again rated the ready manual using the same feedback questionnaire. This tool uses a five-point rating scale varying from very poor to excellent. The rating parameters used and their definitions are provided in Appendix 3. The results of the rating carried out by the three judges are presented in Table 4.1.

Table 4.1

Shows content validation rating of M-PAC by three Speech-Language Pathologists

Sl. no	Parameters	Very poor	Poor	Fair	Good	Excellent
1	Simplicity	-	-	-	1	2
2	Familiarity	-	-	-	3	-
3	Size of the Picture	-	-	-	3	-
4	Colour and Appearance	-	-	1	1	1
5	Arrangement	-	-	1	1	1
6	Presentation of stimulus	-	-	1	1	1
7	Relevance	-	-	-	2	1
8	Complexity	-	-	-	2	1
9	Iconicity	-	-	-	3	-
10	Stimulability	-	-	-	1	2
11	Accessibility	-	-	-	2	1
12	Feasibility	-	-	-	3	-
13	Flexibility	-	-	-	1	2
14	Trainability	-	-	-	1	2

The rating results indicated that 39 out of the total 42 ratings were in the "good to excellent" range, predominantly "good." Few "fair" ratings were also obtained for the color, appearance, arrangement, and presentation parameters.

The "good to excellent" rating of M-PAC can be attributed to several reasons. First, the language used in the material was straightforward, direct, and clear. Next, to make the manual more comprehensible and user-friendly, familiar and simple-to-carryout activities were presented hierarchically based on the task's complexity.

Given the circumstances, it was ensured that the images were appropriate and conveyed the correct meaning corresponding to the stimuli words used. Also, the picture size, colour, and aesthetic appeal encourages greater user involvement and beneficial results. Fourth, the pictures were selected in a way that was more suitable and culturally acceptable for Malayalam-speaking parents and their children. Fifth, the manual's practicality, viability, and flexibility were good enough for the parents to tailor the activities to train their children efficiently. The validators appreciated the material to have a scope of generalization to the natural environment. This meant that the developed material could fulfill its purpose effectively.

Pilot study on children with HI.

To validate M-PAC, a pilot study was conducted to get parent's feedback regarding the manual's implementation. Two children with HI participated in the pilot study, and the parents of these children used the manual to correct their children's articulation of vowels and the velar consonant /k/. One noteworthy suggestion from the parents was to eliminate fill-in-the-blank activities as they were difficult for the children and because some children had not achieved reading and writing yet. Therefore, such activities were changed based on the parent's suggestions and were substituted with naming activities.

4.2 Establishing the efficacy of parent-based articulation intervention for children with HI.

As discussed in the method, the study's second objective to establish the efficacy of parent-based articulation intervention was achieved through five stages. In stage 1, a pretest was conducted on all seven participants, and the three articulatory outcome measures (SODA errors analysis, Proportion of Whole-Word Correctness, and Percentage of speech intelligibility) were obtained. The descriptive statistics of

each participant's pre-test results are tabulated in Table 4.3, and the individual scores of the pre-test results are depicted in Table 4.4.

In the second stage, parents were oriented on using the prepared manual M-PAC to correct Malayalam phonemes in their children through a hybrid mode of four 1-hour sessions per week. Parental feedback regarding ease of using the material reported that all 7 participant's parents felt that the material was easy to use.

In the third stage, the children with HI were trained for four weeks by their parents using M-PAC. Five parents contacted the researcher again to seek help for the training of /r/ and /ɾ/, and two parents for /ʧ/ and /ʈ/ phonemes. Parents of four children also contacted the researcher to correct the voicing errors seen in their children. As expected, all parents reported that vowels were the easiest to correct than consonants, and clusters were the hardest to train. The list of sounds for their ease of correction, as reported by parents, is represented in Table 4.2

Table 4.2

Shows the number of parents reporting the speech sounds corrected using M-PAC

Sounds corrected using M-PAC			Number of parents reporting
Vowels	Consonants	Consonant clusters	
/a/, /i/, /e/, /u/, /o/, /a:/, /i:/, /e:/, /u:/, /o:/	/k/, /ʈ/	-	7
-	/g/, /ʧ/	-	6
-	/ʤ/	/nʈ̪/,/nt/, /nʤ/, and /nɖ̪/	5
-	-	-	4
-	/ɳ/, /ʃ/, /s/, /ʅ/	/ŋg/	3
-	/r/, /ʂ/, /ɖ/	/l̪j/, /ʈ̪j/, /mb/, ʈ̪r/, /pr/, and /kl/	2
-	/ɾ/	/kj/, /gl/, /b̥l/, /st^{h}/, /n̪d̪r/	1
-	-	/sk/, /tr/, /pl/, /sl/, /st^{h}/, /sk/, /sʈ̪/, /sp/, /br/, sʈ̪r/, /gr/, /ʃv/, /kɽ̥/	nil

All seven parents reported the correction of 10 vowels, including short and long vowels. The current finding agrees with the existing literature that consonants are more misarticulated than vowels since vowels do not require as much articulatory precision as consonants (Brannon, 1996; Joy, 2020).

Among consonants, the order of ease of correction of the phonemes reported by the parents was /k/ > /ʈ/ > /ʧ/ > /g/ > /ʤ/ > /ɳ/ > /s/ > /ʃ/ > /ʅ/ > ɖ/ > /ʂ/ > /r/ > /ɾ/. Seven parents reported that stop consonants (velars (/k/) and alveolar (/ʈ/) were the easiest to correct, and affricates and fricatives, followed by alveolar flap (/ɾ/) and retroflex trill (/r/), were the longest and most difficult consonants to be corrected. Similar findings were reported by Eisenberg, 2007; Gordon, 1987; Joy, 2020; Moeller

et al., 2010; Wiggin et al., 2013; Sreedevi & Mathew, 2022. The intricate articulation necessary for the retroflex trill, or the perceptual difficulties of hearing aid users, could be the cause. Similarly, difficulty in the correction of speech sounds /ʧ/ and /ʤ/ can be linked to the inherent sophistication of these sounds or the temporal properties of affricates, as observed in acoustic investigations (Mildner & Liker, 2008). The frequent incorrect productions of the fricatives /s/, /ʃ/, and /ʂ/ are due to the perceptual issues with fricatives that children with HI have (Stelmachowicz, 2004). Errors in consonant voicing confusions between cognate pairs were similarly documented in studies by Carr (1953), Millin (1971), Smith (1975), Mangan (1961), Markides (1970), Nober (1967), and Sreedevi et al. (2022).

All seven parents reported that clusters were the longest and most challenging to correct. The clusters /nʈ/, /nt/, /nʤ/, and /nɖ/ were easily acquired as reported by parents. Similar studies have been documented by McLeod et al. (2001), Dyson (1988), and Saleh et al. (2023). This can be attributed to the fact that the cluster group most difficult for the children to master started with a completely or partially closed vocal tract and shifted quickly to an open one. Since nasal clusters start with a completely or partially closed vocal tract and shift quickly to an open one, they are relatively the first consonant clusters to be acquired.

However, no parents reported the correction of the clusters /sk/, /tr/, /pl/, /sl/, /st^{h}/, /sk/, /sʈ/, /sp/, /br/, sʈr/, /gr/, /ʃv/, and /kɽ/. Possibly, some of these at least would have been corrected with more intervention time given to the parents. The literature also documents that three-element clusters were more challenging to produce than two-element clusters and cluster reduction errors persist for longer in children with HI and are one of the last phonological patterns to be eliminated (Ben-David, 2001; Brannon, 1966; Powell, 1993; Smit, 1993).

After completing the one-month intervention by the parents, in the fourth stage, all seven children with HI were post-tested for the same articulatory outcome measures (SODA errors, Proportion of Whole-Word Correctness, and Percentage of speech intelligibility). The descriptive statistics findings of each participant's post-test results are tabulated in Table 4.3, and the individual scores of the post-test results are depicted in Table 4.4.

In the fifth stage for establishing the efficacy of parent-based intervention, a statistical comparison of the pre-test and post-test outcome measures of Group 1 was carried out.

Statistical Analysis of pre-post articulatory outcome measures.

The pre-post articulatory outcome measures of Group 1 were carried out using SPPS (version 26) to establish the efficacy of parent-based articulation intervention. The descriptive scores obtained by Group 1 for the pre-test and post-test were analyzed for three articulatory outcome measures, namely;

- SODA errors
- Proportion of Whole-Word Correctness (PWC)
- Percentage of speech intelligibility

The results are tabulated in Table 4.3.

Table 4.3

Shows mean, median, standard deviations, and interquartile range of articulatory outcome measures of pre-test and post-test of Group 1.

Sl. No	Articulatory outcome measures for pre-post-test comparison	Pre-test (N=7)				Post-test (N=7)			
		Mean	Median	SD	IQR	Mean	Median	SD	IQR
1	SODA errors	103	90	33	23	62	54	32	46
2	Proportion of Whole-Word Correctness (PWC) (number)	24	26	11	11	45	48	18	40
3	Percentage of speech intelligibility	44	44	12	20	62	67	9	19

Table 4.2 reveals a visible difference in articulatory outcome measures obtained from Group 1 before and after the parent-based articulation intervention using the developed M-PAC. The comparison of the median scores of the pre-post test scores across the three articulatory outcome measures is depicted in Figure 4.1. The individual pre-post test scores of each of the seven participants using M-PAC are presented in 4.4.

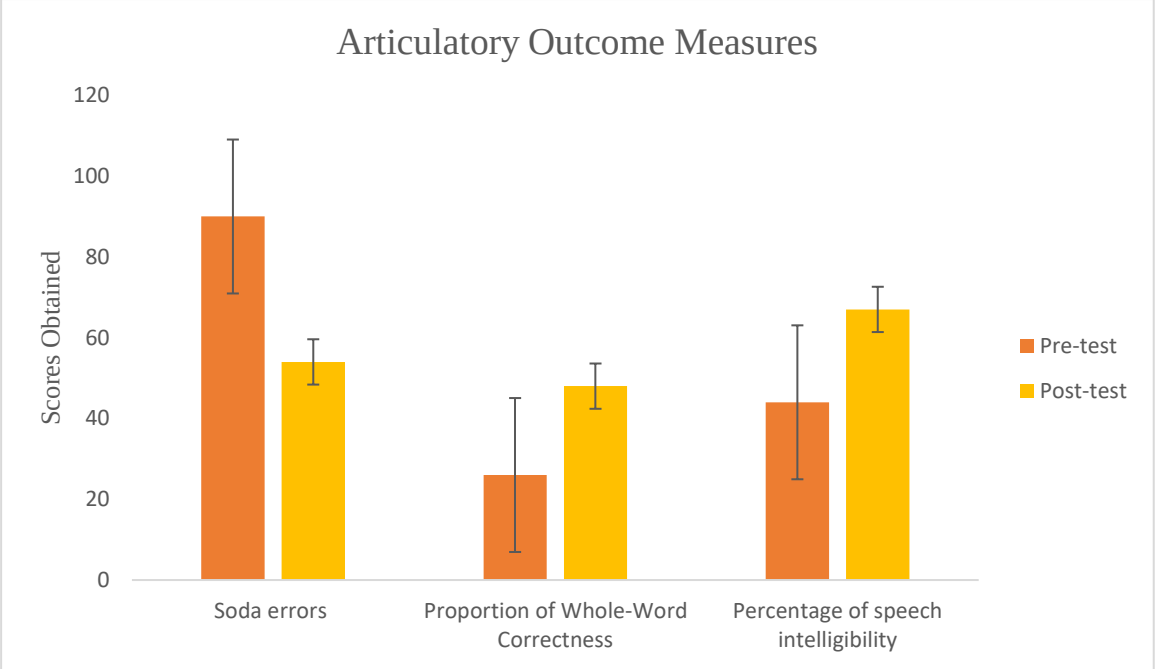

Figure 4.1

Shows median scores of pre and post-test SODA errors, Proportion of Whole-Word Correctness, and Percentage of speech intelligibility of the Group 1 participants.

Table 4.4

Shows the individual scores of each participant on the pre-test and post-test across the articulatory outcome measures

Participants	SODA errors		Proportion of Whole-Word Correctness		Percentage of speech intelligibility	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	73	31	0.40	0.70	58	70
2	90	56	0.29	0.52	36	65
3	109	82	0.19	0.24	44	51
4	86	36	0.30	0.64	56	67
5	90	50	0.26	0.48	41	69
6	96	54	0.23	0.41	51	70
7	174	125	0.4	0.21	23	46

Comparison of Pre-test vs. Post-test of Group 1

For the statistical comparison of the pre-test and the post-test, the responses obtained from the seven participants were first subjected to a normality test using the Shapiro-Wilk test, which revealed a non-normal distribution of the scores. Therefore, the non-parametric equivalent of paired t-test, i.e., the Wilcoxon Signed Rank test, was used to compare the pre-test-post-test performance of Group 1. Wilcoxson's Signed Rank Test revealed the /z/ value as 2.37, a significant difference at 0.05 level. An effect size of 0.63 was also noted, indicating a large effect (>0.5) for all three articulatory outcome measures of Group 1 participants during the post-test. Figure 4.1 shows a visible reduction in the SODA errors and improvement in both the Proportion of Whole-Word Correctness and the Percentage of Speech intelligibility.

A statistically significant difference was noticed for pre-post-test scores in all the articulatory outcome measures, such as the SODA errors, Proportion of Whole-Word Correctness (PWC), and Percentage of speech intelligibility. The median scores were better for the post-test than the pre-test median scores; the error scores reduced significantly, and the overall intelligibility improved. From this observation, it can be concluded that the parent-based articulation intervention using the developed M-PAC improved the articulatory skills of children with HI.

Analysis of the individual scores reveals an increased number of errors were noted for the seventh participant during the pre-post-tests compared to the other participants. This may be due to the reduced gains from the child's hearing aid. A study by Tomblin et al. (2014) also correlates with this finding, where measures of the gain in hearing ability for speech provided by the HA significantly correlated with speech and language ability levels. However, post-test scores revealed improvements in all the participant's articulatory outcome measures, showing that the parent-based

articulation intervention is helpful for children with a greater number of errors.

Similarly, analysis of the individual scores of the pre-tests reveals an increased number of errors for all the participants, correlating to the fact that articulation errors persist even after attending speech therapy for a considerable time. This again substantiates the need for such parent-based articulation interventions using resource manuals.

Several factors may limit the interpretation of the study's findings. Because there were no controls or comparisons to other remediation techniques, it seemed prudent to attribute improvement to the parental intervention alone. However, within the limitations of the current investigation, these findings suggest that the parent-based articulation intervention using M-PAC can enhance articulation competency in children with HI within four weeks.

The present study draws support from several earlier parent-based intervention studies. Buschmann et al. (2008) assessed the efficacy of a brief, highly structured parent-based language intervention group program for 2-year-old children with specific expressive language delays. A pre-post-test was administered, and according to the study, 75% of children in the intervention group had normal expressive language ability, compared to 44% of children in the control group.

The present study is also supported by Cordier et al. (2016), who investigated parent-delivered play-based intervention supported by occupational therapists and speech-language pathologists to improve the pragmatic language skills of children with ADHD. Pre-post-test after seven weeks of parents delivering the intervention reported significant improvements in observed pragmatic language skills for the ADHD children.

In another study, Harrigan and Nikoloupolus (2002) used the Hannen program

to conduct a before-and-after study with 17 parents. The pre-post count of parent initiatives and replies was analyzed using video, and significant increases in parent responsiveness were observed.

Sommers et al. found similar findings in one of the reports as early as 1959. The study also assessed the outcomes of training parents to assist children with functional articulation deficits at home. After a 3.5-week pre-post articulation testing was done, the study revealed rapid improvement of articulation skills of [r], [l], [s], [f], [v], [k], [g], [ʧ], [ʃ], and [θ] and in the initial, medial, and final positions when parent training incorporating activities and games was provided to the child.

Parent video-based training also has shown positive outcomes. Van Balkom et al. (2010) conducted a pre-post comparison of Parent Video Home Training. They discovered that more substantial gains were observed when videos were employed as the primary training component.

Olson et al. (2016) investigated the feasibility of using text messaging to give developmental education to families using a one-group pre-post-test methodology. There was an increase in awareness of language-promoting activities and local child development resources, as well as greater engagement in language-promoting activities and self-reported knowledge, according to pre- and post-program telephone surveys.

On the other hand, Lancaster et al. (2010) investigated the efficacy of SLT-delivered and parent-delivered therapies. Parents were assigned homework assignments for their children and asked to attend therapy sessions. Parent-delivered intervention was adequate but not as successful as SLT-delivered intervention.

The improved performance in articulatory skills of all the children with HI in the post-test could be attributed to one of the following reasons:

- The parents have better understood how various speech sounds are produced due to the researcher's training using the developed M-PAC.
- The parental instruction offered in the children's natural milieu may have increased practice trials more than a 45-minute clinician-led speech therapy session twice a week, thus fostering better generalization.
- The materials and activities offered to the parents for reference may have functioned as a ready resource for the parents to use and facilitate their children readily.
- The frequency of the affect (visual reinforcement) associated with every activity may have motivated the child to practice the speech sounds repeatedly.

Inter-judge reliability and Intra-judge reliability

To ensure the reliability of the articulatory analysis of the data, inter and intra-reliability testing was carried out. For inter-judge reliability, 10% of the audio-recorded story narration samples of each of the seven participants were presented to three judges. Similarly, 10% of the same sample was considered for intra-judge reliability, which the researcher herself carried out.

The evaluators listened to the story narration sample and did the verbatim translation of each participant. The researcher then matched the translation with the actual story narration sample, counted the number of correctly identified words, and calculated each participant’s speech intelligibility scores using the formula.

The statistical measure Cronbach’s alpha was employed to calculate the inter-judge reliability. Findings showed that pre-inter judge reliability was 0.984, and post-inter judge was 0.983. Similarly, for intra-judge reliability, the researcher reanalyzed 10% of the seven participant’s total story narration samples from only the post-test,

and Cronbach's alpha was 0.988. Analysis of the results revealed that the level of agreement for both inter and intra-judge reliability was excellent.

Feedback from parents on the developed M-PAC

After the post-test, feedback was obtained from parents (Group 2) on the content and usefulness of M-PAC. Five feedback questions in Malayalam regarding the manual were sent to the parents, and their feedback was obtained over WhatsApp. The questions used for this are provided in Appendix 4. This questionnaire probed the material's ease, usefulness, and impression. The last two questions in the questionnaire intended to obtain the parent-perceived progress in the child's articulation descriptively and to obtain suggestions from Group 2 to make M-PAC more resourceful. The results of the feedback section are summarized below.

Regarding ease of using the material, all seven participant's parents responded that the manual was easy to use. The second question of the feedback questionnaire was intended to elicit information on the usefulness of the material. All seven parents (100%) in Group 2 responded that they felt the manual helped correct the articulatory errors of their children with HI. The third question probed the parent's impression of the developed manual M-PAC. The response showed that all seven parents (100%) responded that the developed material was appropriate for training children.

The fourth open-ended question indicated the number of phonemes corrected in their children using M-PAC. All seven parents (100%) reported that the Group 1 participants corrected all the vowels in the initial position. They also reported that improvements were noted in their children for at least 5-9 consonants using M-PAC. Three to five parents reported improvements in four clusters having a nasal consonant (nt̪/,/nt/, /ndʒ/, and /nd̥). The parents also reported that the phonemes in the child's repertoire improved clarity. Five parents reported phonemes previously produced

correctly in the children's word-initial positions to be correctly produced in the medial and final positions also after the parent-based articulation intervention using the manual.

The fifth and last question was to obtain suggestions on making the manual more resourceful. One important suggestion was to provide more duration for the parent-based articulation intervention using the material; as the present study was a time-bound dissertation study, it was not feasible to give more time to the parents to carry out the training. The second suggestion was to eliminate the writing activities. However, this would be possible when the parents have more time to complete the intervention. One parent responded that writing task activities excited the child more. They all stated that the articulation of 10 vowels and a minimum of 5 out of 13 consonants were corrected within a span of one month. Parents also said that 4 clusters showed improvements after the parent-based articulation intervention. Most parents also stated a need to extend the training duration for the parent-based articulation intervention using M-PAC to further improve their children's articulation skills. Nevertheless, even after the post-test, the parents could continue the training. The feedback received from all the parents on the developed M-PAC and parent-based articulation intervention was positive.

Sommer et al. (1959) conducted a similar study. After the clinical training, a feedback questionnaire was distributed to the parents who received parent training in both the control and experimental groups. Both groups of parents had a favorable attitude toward the therapy program. The questionnaire responses were quite similar for the two groups of parents, with the experimental group slightly more favorable than the control group. This lack of difference in the questionnaire's responses could indicate that parents who enroll their children in such a program are a grateful and

appreciative group.

Our encouraging findings may be attributed to the fact that all the parents opined that the manual was easy and helpful as it helped them correct the articulatory errors in their children with HI. All the feedback obtained suggests that the parent-based articulation intervention using M-PAC improved the articulatory skills of Malayalam-speaking children with HI.

To summarize, the results of the present study indicated that the Parent-based articulation intervention using the developed M-PAC was effective in Malayalam-speaking children with HI. Such interventions can be time and cost-effective because the parents can carry out the activities at their own homes at their convenience, and the clinicians can also be more hopeful of seeing more improvements in their clients. More structured home training results in better involvement of parents in the intervention program. Children feel less stressed and more comfortable as the training could be more flexible. Therefore, it is beneficial for the client, the parents, and the clinicians to improve the articulation abilities of children with HI. Articulation intervention also substantially reduces the impact of speech sound errors on the quality of life of children and their parents. Hence, there is a need to carry out similar studies, including more children with HI of different languages across India.

Chapter 5

SUMMARY AND CONCLUSIONS

Hearing loss is one of the most prevalent disorders affecting children's speech intelligibility skills, rendering them poor social functioning and quality of life. With recent developments in hearing aids and cochlear implants, speech intelligibility has improved. However, it still poses a big challenge. Parent-based articulation intervention studies have successfully improved patient outcomes in various allied health fields, especially speech sound disorders.

Empowering and training parents with the know-how on articulation intervention can easily facilitate children with hearing impairment or any other condition with speech sound errors to improve their speech intelligibility. In addition, parents know their children better since they spend more time with them. Hence, they are more successful in providing intensive treatment and meaningfully integrating articulation goals into the child's daily life. Therefore, it is ideal that parents are adequately involved in an intervention process. Especially after the COVID pandemic, there are a lot of different online programs that are available for Speech-language pathologists. They are intended for the clinician-mediated approaches. Many minimal pairs and drill materials are available in different languages and English. Most of these materials are clinician-mediated. However, a compiled simple and easy-to-administer manual developed by considering caretakers and parents, especially in Indian languages, is lacking. Thus, the present study was an attempt to develop material in Malayalam and check how efficient a parent-based articulation intervention is.

The present study aimed to develop a manual in Malayalam and to evaluate the efficacy of parent-based articulation intervention in children with HI. Two groups

of participants were recruited for the study. Group 1 included 7 Malayalam speakers diagnosed with moderate to profound hearing loss fitted with suitable hearing aids, who had undergone therapy for at least two years, and in the age range of 5 to 10 years. The criteria for inclusion were that these children should have a speech intelligibility score of less than 60% and use 2–3-word sentences while communicating. Group 2 consisted of the parents of the Malayalam-speaking children with HI participating in Group 1.

A parent-based articulation training manual (M-PAC) was developed, which incorporated 51 phonemes (10 vowels, 13 consonants, and 28 clusters) of Malayalam and was validated by three Speech-Language Pathologists. Following this, a pre-test was conducted to obtain three articulatory outcome measures (SODA errors, Proportion of Whole Word Correctness, and Percentage of Speech Intelligibility). The material used for the assessment was Malayalam Articulation Test-Revised (MAT-R) and a story narration stimulus. After the manual's preparation and content validation, it was named M-PAC. Group 2 (parents of each child) was trained by the researcher using M-PAC, and they were given a time frame of one month to carry out the parent-based articulation intervention in their child with HI. After the intervention by the parents, a post-test was carried out to obtain the same three articulatory outcome measures.

The data distribution was non-normal, so the statistical analysis was computed using Wilcoxson’s sign-ranked test to compare the pre-test and post-test. The scores of the outcome measures were statistically analyzed, and descriptive measures were also obtained. The statistical analysis revealed a reduction in the SODA errors and improvement in both the Proportion of Whole-Word Correctness and the Percentage of Speech intelligibility.

Hence, the results of the present study revealed that empowering parents for

articulation intervention for children with HI can yield a positive outcome. The feedback received from the parents suggested that the manual helped to improve the child's articulatory skills. They also reported that all vowels, at least 5 to 9 consonants, and four consonant clusters with nasal groups were corrected within the timeframe of one month assigned to them. Most parents suggested that longer intervention can improve the children's speech intelligibility further.

5.1 Implications of the study

- The presently developed user-friendly manual can improve children's speech intelligibility with HI through intervention by parents, thus reducing the load on SLPs.
- Children with HI often must wait long for speech therapy appointments, so such manuals can help parents train them.
- Children with communication disorders tend to often have speech sound errors (intellectual disability, cerebral palsy, cleft lip and palate, childhood apraxia of speech, developmental speech sound disorder). Hence, parents of children with other communication disorders can also benefit from this manual.
- Parents get an opportunity to train their children at their own pace with access to the material whenever needed, thus enabling more flexibility in training.
- The online materials like PowerPoint can provide an opportunity for training many parents without the physical presence of SLPs or any logistical requirements.
- Empowering parents to facilitate their child's articulation skills is a feasible intervention approach, with parents acting as empowered agents to improve the articulatory skills of their children.
- This manual can be improvised by adding a greater number of phonemes for correction.

- The efficacy of the manual can be established by giving more training periods.
- This manual is a cost-effective material that can readily be used by SLPs, thereby avoiding the tedious task of preparing interventions for home training and counseling.

5.2 Limitations of the study

- The participants in the study were small in number.
- The time frame for the training was only one month.

5.3 Future Directions

- This manual can be improvised by adding a greater number of phonemes for correction.
- The efficacy can be established by giving more training periods.
- Similar manuals can be prepared for the intervention of other clinical groups.
- The present manual for intervention by parents can be developed in other Indian languages.

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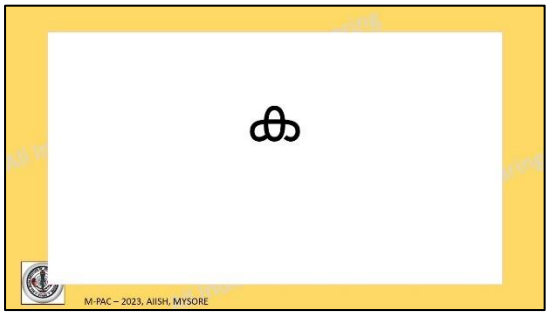
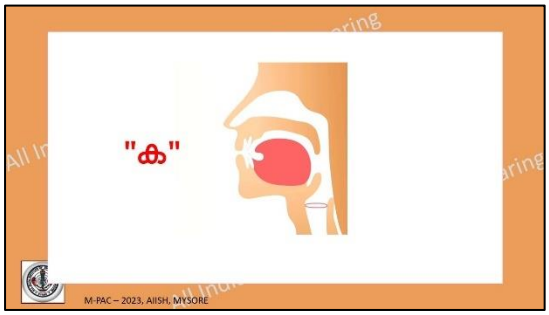
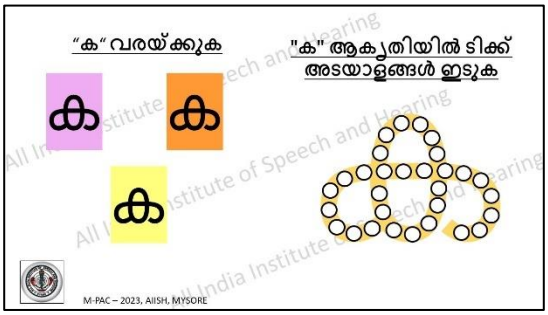
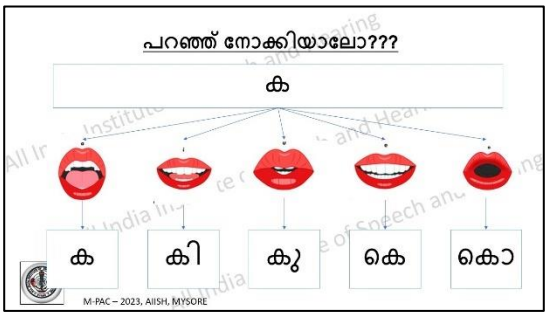
APPENDIX 1

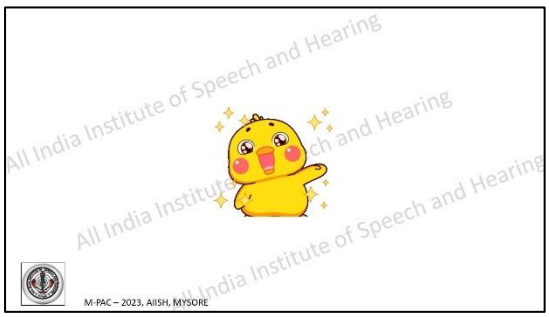
Shows the sample of the intervention manual M-PAC for one phoneme /k/.

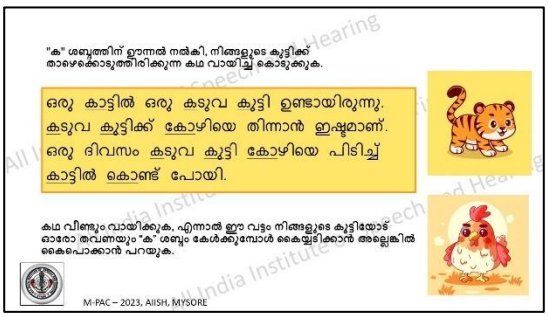












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ജോഡി വാക്കുകൾ ഉറക്കെ പറയുക, അവ സെയിം ആണെങ്കിൽ കൂട്ടി ✓ തൊടണം അല്ലെങ്കിൽ കൂട്ടി ✗ തൊടണം

1. കരം - കരം
2. പല്ല് - കല്ല്
3. തറ - കറ
4. പാതി - പാകി
5. കാറ്റ് - കാറ്റ്
6. പറ - കറ
7. കായൽ - പാജൽ

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കോഴിയെ കൂട്ടിൽ
എത്തിച്ചാലോ ..

കു.....!!!!

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എത്തിച്ചാലോ ..

കു.....!!!!

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"ക" എന്ന അക്ഷരത്തിൽ തുടങ്ങുന്ന വാക്കുകൾ തിരിച്ചറിഞ്ഞ് ടിക്ക് ചെയ്യുക

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ഉത്തരം: കുപ്പി, കൊട്ടാരം, കിണർ, കശുവണ്ടി

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"ക" എന്ന അക്ഷരത്തിൽ അവസാനിക്കുന്ന വാക്കുകൾ തിരിച്ചറിഞ്ഞ് ടിക്ക് ചെയ്യുക

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ഉത്തരം: പാർക്ക്, ബുക്ക്, പടക്കം

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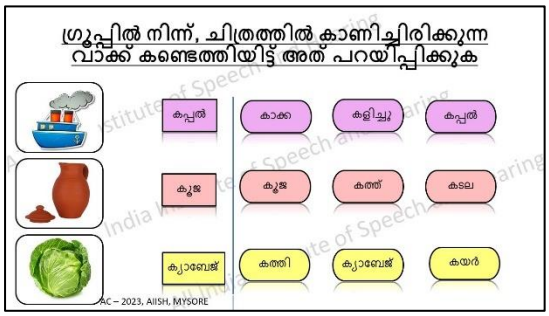

ഗ്രൂപ്പിൽ നിന്ന്, ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്ന വാക്ക് കണ്ടെത്തിയിട്ട് അത് പറയിപ്പിക്കുക
കപ്പൽ
കാക്ക
കളിച്ചു
കപ്പൽ
കൂജ
കൂജ
കത്ത്
കടല
ക്യാബേജ്
കത്തി
ക്യാബേജ്
കയർ
M-PAC – 2023, AIISH, MYSORE

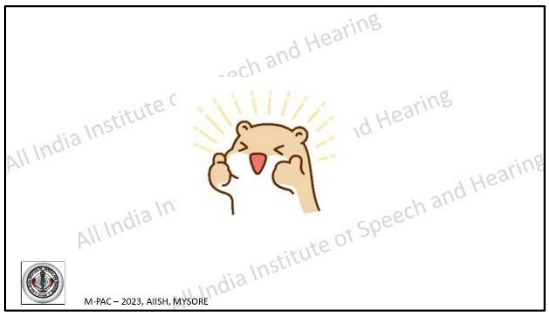

CONGRAULATIONS
M-PAC – 2023, AIISH, MYSORE


“ക” അക്ഷരം ഉപയോഗിച്ച് ചിത്രത്തിന് പേര് നൽക്കുക
കുതിര
കുരു
കളി
കല്ല്
ക
കണ്ണ്
കേക്ക്
കാപ്പി
M-PAC – 2023, AIISH, MYSORE


CONGRATULATIONS!
M-PAC – 2023, AIISH, MYSORE


വാക്കിന്റെ ആദ്യസ്ഥാനത്തുള്ള "ക" ചേർത്ത് പറഞ്ഞ് നോക്കിയാലോ
കുട
കട്ടിൽ
കണ്ണട
കടല
M-PAC – 2023, AIISH, MYSORE

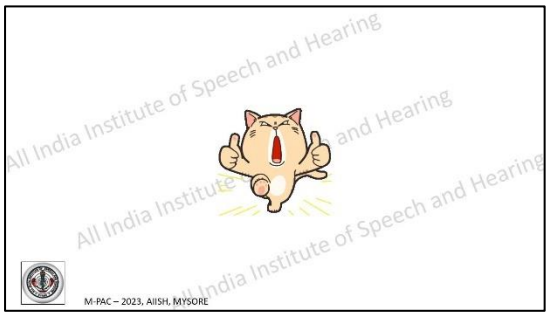

വാക്കിന്റെ ആദ്യസ്ഥാനത്തുള്ള "ക" ചേർത്ത് പറഞ്ഞ് നോക്കിയാലോ
കൈ
കത്രിക
കാറ്റ്
കമ്പ്യൂട്ടർ
കത്തി
കവിൾ
M-PAC – 2023, AIISH, MYSORE

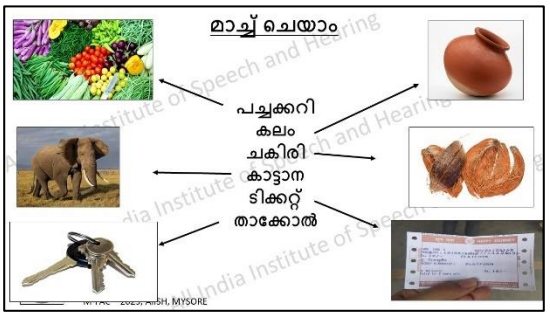

M-PAC – 2023, AIISH, MYSORE

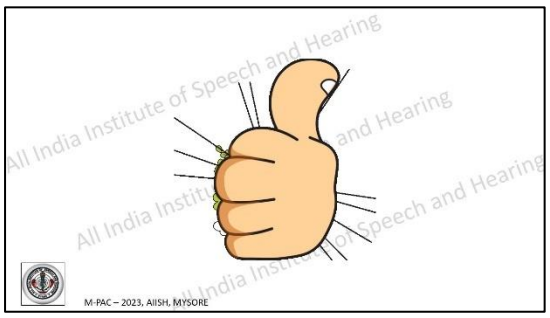

വാക്കിന്റെ നടുവിലെ സ്ഥാനത്തുള്ള "ക" ചേർത്ത് പറഞ്ഞ് നോക്കിയാലോ
ആകാശം
ബക്കറ്റ്
തക്കാളി
ബ്ലോക്സ്
അടുക്കള
മൂക്കുത്തി
M-PAC – 2023, AIISH, MYSORE

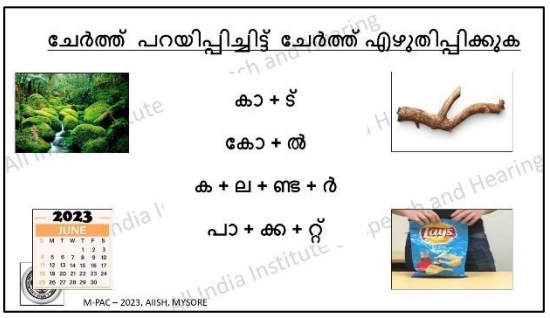

Perfect!
M-PAC – 2023, AIISH, MYSORE

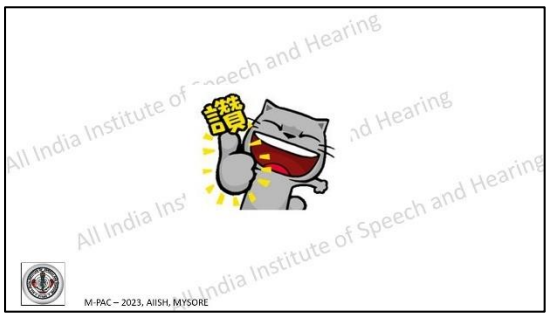

വാക്കിന്റെ അവസാന സ്ഥാനത്തുള്ള "ക" ചേർത്ത് പറഞ്ഞ് നോക്കിയാലോ
പാവക്ക
ചക്ക
കൊക്ക്
പതാക
തോക്ക്
ചട്ടുകം
M-PAC – 2023, AIISH, MYSORE

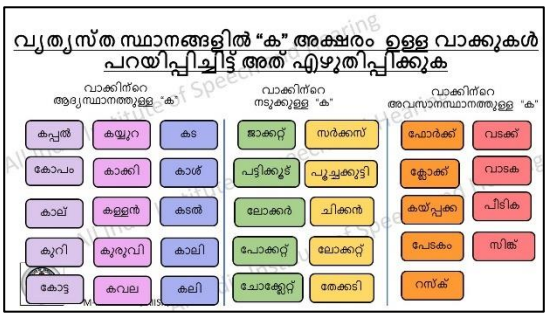

M-PAC – 2023, AIISH, MYSORE


മാച്ച് ചെയാം
പച്ചക്കറി
കലം
ചകിരി
കാട്ടാന
ടിക്കറ്റ്
താക്കോൽ
M-PAC – 2023, AIISH, MYSORE


M-PAC – 2023, AIISH, MYSORE


ചേർത്ത് പറയിപ്പിച്ചിട്ട് ചേർത്ത് എഴുതിപ്പിക്കുക
കാ + ട്
കോ + ൽ
ക + ല + ണ്ട + ർ
പാ + ക്ക + റ്റ്
2023
JUNE
M-PAC – 2023, AIISH, MYSORE


M-PAC – 2023, AIISH, MYSORE


വ്യത്യസ്ത സ്ഥാനങ്ങളിൽ “ക” അക്ഷരം ഉള്ള വാക്കുകൾ പറയിപ്പിച്ചിട്ട് അത് എഴുതിപ്പിക്കുക
വാക്കിന്റെ ആദ്യസ്ഥാനത്തുള്ള “ക”
വാക്കിന്റെ നടുക്കുള്ള “ക”
വാക്കിന്റെ അവസാനസ്ഥാനത്തുള്ള “ക”
കപ്പൽ
കയ്യൂറ
കട
കോപം
കാക്കി
കാശ്
കാല്
കള്ളൻ
കടൽ
കുറി
കുരുവി
കാലി
കോട്ട
കവല
കലി
ജാക്കറ്റ്
സർക്കസ്
പട്ടിക്കൂട്
പൂച്ചക്കുട്ടി
ലോക്കർ
ചിക്കൻ
പോക്കറ്റ്
ലോക്കറ്റ്
ചോക്ലേറ്റ്
തേക്കടി
ഫോർക്ക്
വടക്ക്
ക്ലോക്ക്
വാടക
കയ്പ്പക്ക
പിടിക
പേടകം
സിങ്ക്
റസ്ക്
M-PAC – 2023, AIISH, MYSORE


OMG!
M-PAC – 2023, AIISH, MYSORE


താഴെയുള്ള വാക്യങ്ങൾ വായിക്കുക
1. കാർ കുഴിയിൽ വീണു.
2. കാട്ടിൽ കരടി ഉണ്ട്.
3. ചെണ്ട കൊട്ടുന്നത് ഞാൻ കേട്ടു.
4. അമ്മ ചിക്കൻ കറി ഉണ്ടാക്കി.
5. എനിക്ക് കുറുക്കന്റെ കഥ ഇഷ്ടമാണ്.
Alice
M-PAC – 2023, AIISH, MYSORE


OK
M-PAC – 2023, AIISH, MYSORE


ഇവിടെയുള്ള ചിത്രങ്ങൾ ഉപയോഗിച്ച് ചെറിയ വാക്യങ്ങൾ സൃഷ്ടിച്ചിട്ട് അത് പറയിപ്പിക്കുക
ഞാൻ ___ കണ്ടു
എനിക്ക് ___ വേണം
എനിക്ക് ___ ഇഷ്ടമാണ്
കപ്പ
കള്ള്
കക്ക
കസേര
കാരറ്റ്
കപ്പ്
M-PAC – 2023, AIISH, MYSORE

താഴെ നൽകിയിരിക്കുന്ന ഭാഗം വായിച്ച് ചോദ്യങ്ങൾക്ക് ഉത്തരം നൽകുക.

ഒരു കാട്ടിൽ ഒരു കടുവ കുട്ടി ഉണ്ടായിരുന്നു. കടുവ കുട്ടിക്ക് കോഴിയെ തിന്നാൻ ഇഷ്ടമാണ്. ഒരു ദിവസം കടുവ കുട്ടി കോഴിയെ പിടിച്ച് കാട്ടിൽ കൊണ്ട് പോയി.

ചോദ്യങ്ങൾ

1. കാട്ടിൽ ആരായിരുന്നു ഉണ്ടായിരുന്നത്?
2. കടുവ കുട്ടിക്ക് എന്ത് ആയിരുന്നു തിന്നാൻ ഇഷ്ടം?
3. കടുവ കുട്ടി കോഴിയെ എങ്ങോട്ടാ കൊണ്ട് പോയത്?

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ഉത്തരം: കടുവ കുട്ടി, കോഴിയെ, കാട്ടിൽ

APPENDIX 2

Shows the format of the log book for progress documentation by parents.

തീയതി (Date)			പ്രവർത്തനം (Activity)					
വാക്കിന്റെ ആദ്യം (Initial position)			വാക്കിന്റെ നടുക്ക് (Medial position)			വാക്കിന്റെ അവസാനം (Final position)		
പറഞ്ഞ അക്ഷരത്തിന്റെ കൃത്യത (Accuracy percentage): ---- %			പറഞ്ഞ അക്ഷരത്തിന്റെ കൃത്യത (Accuracy percentage): ---- %			പറഞ്ഞ അക്ഷരത്തിന്റെ കൃത്യത (Accuracy percentage): ---- %		

APPENDIX 3

Shows feedback questionnaire used for content validation of the material.

Name of the Validator: Designation of the Validator:

Sl. no	Parameters	Very Poor	Poor	Fair	Good	Excellent
1.	Simplicity					
2.	Familiarity					
3.	Size of the Picture					
4.	Color and Appearance					
5.	Arrangement					
6.	Presentation					
7.	Relevance					
8.	Complexity					
9.	Iconicity					
10.	Stimulability					
11.	Accessibility					
12.	Feasibility					
13.	Flexibility					
14.	Trainability					

Definition of Parameters

1. Simplicity: Are the test stimuli / Material comprehendible?
2. Familiarity: Is the test material familiar to the user?
3. Size of pictures: Whether the picture stimuli are of appropriate size?

4. Color and appearance: Are the picture stimuli appropriate in terms of color and dimension?
5. Arrangement: Whether the picture stimuli are within the visual field of an individual?
6. Presentation? Are the number of stimuli in each section placed appropriately?
7. Relevance: Whether the test material is culturally and ethically acceptable?
8. Complexity: Is the material arranged in the increasing order of difficulty?
9. Iconicity: Does the picture stimuli appear to be recognizable and representational?
10. Stimulability: Does the stimulus material elicit responses from the individuals?
11. Accessibility: Is the test material user-friendly?
12. Feasibility: Whether the test material is viable?
13. Flexibility: Can the stimuli be easily modified?
14. Trainability: Can the stimuli be used in for intervention purposes in different milieu?

APPENDIX 3

Shows questions used to obtain feedback from parents regarding the developed M-PAC and its usefulness.

1. **ഈ മാനുവൽ ഉപയോഗിക്കാൻ എളുപ്പമായിരുന്നോ?**

- **അതെ**
- **അല്ല**

2. **ഈ മാനുവൽ സഹായകമായിരുന്നോ?**

- **അതെ**
- **അല്ല**

3. **ഈ മാനുവലിനെക്കുറിച്ച് നിങ്ങളുടെ അഭിപ്രായം എന്താണ്?**

- **നല്ലത്**
- **മോശം**

4. **ഈ മാനുവൽ ഉപയോഗിച്ചിട്ട് നിങ്ങളുടെ കുട്ടിയുടെ എത്ര അക്ഷരങ്ങളിൽ പ്രോഗ്രസ്സ് ഉണ്ടായി?**

5. **ഈ മാനുവൽ എങ്ങനെ കൂടുതൽ മെച്ചപ്പെടുത്താം എന്നതിനെക്കുറിച്ചുള്ള നിങ്ങളുടെ ആശയം പറയാമോ?**