DEVELOPMENT AND VALIDATION OF A VISUAL LIBRARY OF AUDITORY AND SPEECH BEHAVIOURS IN INFANTS

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This Dissertation is submitted as a part of fulfillment for the

Degree of Master of Science (Audiology)

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JUNE, 2026

CERTIFICATE

This is to certify that this dissertation entitled **"Development and Validation of a Visual Library of Auditory and Speeech Behaviours in Infants"** is a bonafide work submitted as part of fulfilmentof the degree of Master of Science **(Audiology)** of the student with Registration Number **P01II24S023037**. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled **"Development and Validation of a Visual Library of Auditory and Speech Behaviours in Infants"** has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled "**Development and Validation of a Visual Library of Auditory and Speech Behaviours in Infants**" is the result of my own study under the guidance of **Dr. Indira C.P., Assistant Professor of Audiology**, All India Institute of Speech and Hearing, Mysuru and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

Mysuru
June, 2026

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Acknowledgements

I extend my gratitude to ***Prof. M Pushpavathi****, Director of AIISH, for providing an opportunity to carry out my dissertation*

I would like to express my sincere gratitude to my guide ***Dr. Indira C.P*** *for the constant support, guidance and encouragement provided throughout the course of my dissertation. Beyond being an excellent guide, their positive personality, kindness, and dedication have been truly inspiring. Thank you, ma'am, for being a wonderful guide and thoughtful insights.*

A special thanks to ***Nichu****, the one who fills my life with laughter, warmth, and endless comfort. Thank you for being my constant through every phase of life, for believing in me even when I doubted myself, and for standing beside me with so much love that even the hardest moments felt lighter. Your presence has been my strength, my happiness, and one of the most beautiful parts of my journey.*

Heartfelt thanks to my ***Appa, Amma, and Vichu*** *for always standing by me with endless love, unwavering support, and constant encouragement. Your sacrifices, care, and belief in me have shaped me into the person I am today. Through every challenge and every success, your presence has been my greatest strength, and I am forever grateful for the love, guidance, and warmth you have given me throughout my journey.*

I would also like to thank my friends ***Nihala, Parvathy, Karnika, Agraja, Akhila, Neeraja*** *who stood by me during tough times and made my MSc life much less stressful, more fun, and truly memorable. A special mention to my dissertation partner* ***Amal*** *for making my dissertation life so joyful and full of laughter. A big thanks to my* ***B Section***

***classmates**, especially our **Vina Faluda team : Safa, Zaithuna, Vardha, and Lulu**, for making my classroom days full of fun memories,*

I would like to sincerely thank all the professionals who participated in my study and provided valuable inputs, suggestions, and support throughout the research process. A special thanks to **Dr. Lakshmi** for her guidance, valuable suggestions, and support throughout this study.

Heartfelt gratitude to the parents who trusted us and kindly allowed us to record videos of their children.

Above all, I thank God for His endless blessings, strength, and guidance, which carried me through every challenge and made this journey possible

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ABSTRACT

Early identification and intervention of hearing loss is crucial for speech, language and cognitive development in children. In India, there is no structured NHS program, and parents lack awareness to effectively monitor early auditory and speech milestones, which delays the average age of identification of hearing loss to 2-3 years.

The study aimed to develop and validate a video-based visual library of auditory and speech behaviours in infants aged 0-6 months, to enable parents to recognise typical developmental behaviours.

A behavioural checklist of age-appropriate auditory and speech behaviours was developed for infants. Videos representing each behaviour were recorded from infants. The recorded videos were validated by professionals and parents, who identified the recorded behaviours from the videos and matched them to age-appropriate groups.

A behavioural checklist comprising 10 auditory and speech behaviours was developed for the 0-2 and 3-6 months age ranges. Three videos were recorded for each behaviour, making a visual library of 30 videos in total. Professionals had high accuracy in matching the videos with behaviours and in age range identification. However, parents had considerably lower accuracy, especially for subtle behaviours, highlighting a significant gap in parental awareness of early auditory and speech milestones.

The recorded videos were found to be professionally validated and a culturally appropriate tool for representing the auditory and speech behaviours of Indian children. These videos can be used for parental counselling and student training, thereby promoting early suspicion, identification and intervention of hearing loss.

Keywords: *Newborn hearing screening, early identification and intervention, hearing loss, auditory milestones, speech-language milestones, parental awareness, video-based counselling, Delphi method, parental counselling, developmental monitoring*

Chapter1

INTRODUCTION

The initial two years of a child's life are crucial for speech and hearing development. It is the period during which infants lay the building blocks essential for language, cognitive, and socio-emotional development (Moeller & Tomblin, 2015). Consequently, the brain is most sensitive to language stimulation through the first three years of life; early detection and subsequent intervention of speech or auditory delay immensely enhances the efficacy of early treatments (Yoshinaga-Itano, 2003)

Studies repeatedly show that children with hearing impairments identified early and receiving intervention, particularly during the first six to twelve months of life, have significantly better speech, language, and cognitive skills (Yoshinaga-Itano et al., 2017). Normal language development in children with hearing loss leads to their successful integration into mainstream educational and social environments (Constantinescu-Sharpe et al., 2017).

According to the JCIH (2019) Position Statement, all infants should undergo hearing screening by one month of age, receive a diagnostic audiological assessment at three months if they fail and are diagnosed with hearing loss, and then receive intervention services by six months of age. These recommendations exist because, in the current age, the process of identification of congenital hearing loss is easier and faster due to advancements in technology. Tools like the OAE and AABR are excellent screening tools with very high sensitivity and specificity. The nations that have implemented UNHS are therefore able to meet the recommended timeline by JCIH (2019). This includes testing infants with high-risk factors for developing hearing loss and implementing hearing screening programs at various periods throughout the

first ten years of life (Ruben, 1991). In the absence of a UNHS program, however, there is a significant issue where children with hearing loss are identified late.

Even though JCIH has given the 1-3-6 guidelines for identification and intervention of hearing loss, these guidelines are not implemented in India. Neumann et al. (2020) found in the global survey that less than 1% of infants born in India undergo screening for hearing loss. The country currently lacks a uniformly implemented national programme for newborn hearing screening (Galhotra & Sahu, 2019). Consequently, the average age of identification of hearing loss in the Indian population is found to be well above the desired age of 3 months, as given by JCIH (2019). The age of identification of congenital hearing loss reported in literature varies between 1.5 years (Rout & Singh, 2010) and 22.85 months (Subodh & Rangasayee, 2011).

This delay in the age of identification of hearing loss is due to a lack of proper resources and comprehensive hearing screening programs. This delay will further impact the overall success of any rehabilitation programs (Kumar & Mohapatra, 2011)

In countries where NHS programmes are successfully implemented, only a portion of the referred babies are followed up, and among those diagnosed, only a portion are intervened within the time frame given by JCIH (Deng et al., 2020). This indicates that factors other than implementing the NHS determine the age of diagnosis and intervention of hearing loss. One such factor is the help-seeking behaviour of parents of children with hearing loss. Factors that can serve as barriers to the timely help-seeking among parents include: lack of awareness about hearing loss and its consequences, superstitious beliefs, poor financial status, limited accessibility to

services, difficulty in suspecting hearing loss in an otherwise normally developing child, occasional normal responses to sounds from the child, and being occupied with other life commitments (Pazhayapisharath & Maruthy, 2024). These barriers can delay the age of identification and intervention of hearing loss in children. There are also factors that serve as motivators to parental help-seeking, such as family support, family history of hearing loss, self-motivation and positive attitude (Pazhayapisharath & Maruthy, 2024). These factors are even more important in instances where the NHS is not in place, and the onus of suspecting hearing loss in the child falls on the parent.

Further, even the NHS has its drawbacks. Since most of the permanent hearing loss has congenital origin, it can be identified at birth through hearing screening programs. However, research indicates that a large number of children may develop progressive or late-onset hearing loss, which may not be detected through newborn hearing screening (Núñez Batalla et al., 2023; Pan et al., 2024). There is a prevalence of 25–50% of delayed onset hearing loss that can develop after the neonatal period (Harlor et al., 2009; Wood et al., 2015). Thus, the NHS is not entirely reliable for detecting all instances of hearing loss in early childhood; therefore, it is recommended that hearing be closely monitored throughout childhood (Dedhia et al., 2013). Although the infant has passed the newborn hearing screening successfully, it is recommended to continue monitoring and take parental concerns about hearing impairment seriously (Lutman et al., 1997).

1.1 Monitoring of Developmental Milestones

The American Academy of Paediatrics (AAP) recommends conducting ongoing screening and developmental monitoring to identify those children with developmental delays or disabilities, including hearing loss, as early as possible to enhance early intervention and improve the effectiveness of intervention. Developmental screening tools use standardised screening instruments to track the developmental milestones of growing children (Zubler et al., 2022).

Babies go through a series of developmental milestones in communication beginning from responding to sound at birth, cooing, babbling, voice recognition, startling to loud noises, and finally producing meaningful words. If these milestones are not met, it may be a sign of hearing loss, speech and language disorders, or neurological conditions (CDC, 2022).

Auditory milestones are observable behaviours that indicate whether a baby or a toddler is responding to sounds properly, reflecting the child's hearing development. According to the JCIH (2019), normal auditory milestones include startle response to loud sounds at birth, calming down on hearing familiar voices by one month of age, orientation towards sound by 4 to 6 months, and recognizing and responding to name calls by 6 to 9 months. Absence of observable signs helps in the detection of hearing difficulties.

Similarly, monitoring of speech and language milestones is important in the early detection of hearing impairment in children because hearing is the basis for normal speech and language acquisition (ASHA, 2020). Deviations from standard developmental milestones like babbling at 6 months, single-word use at 12 months, or word combinations at 24 months can be an early sign of hearing impairment (CDC, 2022). Hence, continuous monitoring of speech and language milestones in children

helps in early appropriate referrals and timely intervention, eventually leading to improved communication, social, and educational outcomes (Moeller, 2000).

Since parents are the first to notice their child's progress and daily activities, they play a major role in monitoring their child's developmental milestones. Parents can detect potential delays or atypical development early on by routinely monitoring their child's hearing, speech, language, motor skills, and social interaction. Research has shown that when parents have the correct tools and information, like milestone checklists and developmental tracking apps, they will become active partners in monitoring the developmental process of their child and are more likely to seek early professional intervention when they have concerns (Ben-Sasson et al., 2022). Programs like the CDC's "Learn the Signs- Act Early" campaign aim to educate and support parents, thereby playing a very critical role in enhancing early detection and intervention outcomes (CDC, 2022).

Tools have been created, including the CDC Milestone Tracker and the ASHA developmental milestones chart, which offer benchmarks to track early communication habits of children. (CDC, 2022; ASHA, 2023). Use of checklists in routine health care monitoring and developmental surveillance has been found to increase parental sensitivity and professional decision-making in identifying developmental delays at the earliest, ultimately enhancing long-term speech and language outcomes of the child (Sices, 2007).

For example, the CDC Milestone Tracker mobile app is a free, interactive tool that allows parents, caregivers, and health care providers to track the developmental milestones in a child from 2 months through age 5. One of the unique and useful features of the app is its library of brief, age-based videos that visually depict major developmental behaviours, such as the way a baby reacts to sound, gestures, or starts

to develop words. These videos are handy resources so that parents can compare the child's behaviours with normal development patterns, making it easier to identify concerns earlier. This application also includes standard checklists for developmental milestones, suggestions for promoting a child's development, and alerts for regular check-ups, allowing parents and caregivers to play an active role in tracking and supporting the child's growth (CDC, 2022).

1.2 Need for the Study

Auditory, speech, and language milestones are the most important early childhood developmental milestones as they are precursors of language development, socialization, learning, and cognitive development (Mulrine, 2015). Although newborn hearing screening programs such as Early Hearing Detection and Intervention (EHDI) have improved the early identification of hearing impairments in countries where UNHS is implemented, they do not eliminate the possibility of children experiencing late-onset, progressive, or mild hearing issues that might arise after the newborn period (JCIH, 2019). In a country like India, where the NHS is not implemented universally, parents play a major role in suspecting hearing loss in a child. Hence, parental awareness and help-seeking behaviours significantly impact early identification and intervention of hearing loss. Consequently, continuous monitoring of development, particularly about speech and hearing milestones, is crucial to ensure that children are progressing typically and to quickly recognize any developmental delays (Lipkin, 2020).

Even though many checklists are available to track auditory, speech, and language milestones, these tools are dependent on parental recall and their subjective reporting of the milestones, which can vary significantly because of the

parents' poor knowledge about the developmental milestones and behavioural expectations (Glascoe & Marks, 2011).

Studies have indicated that most parents are not well-informed about auditory and speech-language milestones, and consequently may be unaware of early signs of delay (Moeller & Tomblin, 2015; Pallavi and Wakins, 2011). Parents tend to show more responsiveness to observable developmental milestones like motor milestones when compared to those that are auditory, speech, and language, and are less observable and less obvious (Alghamdi & Altirkistani,2023). Parents mainly monitor behavioural responses to loud sounds, which can be reliably observed even by a trained professional, around 6 months of age (Thompson & Weber, 1974). Additionally, speech and hearing delays are commonly labeled as behavioural or temperamentary characteristics by parents, instead of being regarded as warning signs for developmental delays (Glascoe & Marks, 2011).

This lack of awareness can result in delayed referrals and intervention, which is most effective during the first two years of life, a period marked by significant brain growth and neuroplasticity (Yoshinaga-Itano et al., 2017; Tierney & Nelson, 2009). Hence, there is a need to develop tools that will help parents identify the typical developmental milestones of growing children. Videos have been successfully applied within early childhood research and practice to show developmental behaviours and to train parents to monitor their child's developmental milestones (Karama & Simon, 2022). Video references of speech and auditory behaviours allow for visual checking of items on a checklist and increase agreement among professionals and parents in identifying the milestones in children. These video exemplars will have two functions: as reference videos that demonstrate normal development of a child, and as counselling tools that professionals can use to explain the developmental

behaviours of the child and thereby involve parents in follow-up consultations. Hence, this method will facilitate clinical decision-making as well as provide parental insight into developmental milestones and thereby promote family-centered intervention.

Even though the CDC has created a Milestone Tracker App that guides parents and caregivers in monitoring normal developmental milestones with the support of video references that show typical developmental milestones in children, the material is predominantly created in a Western cultural context. It has not been standardized and culturally adapted for the Indian population. Even though this application provides video references showing developmental milestones in different domains, such as communication, motor, cognition and social skills, these visual references are not necessarily representative of culturally different care giving practices or behavioural norms seen among Indian children (Chandrashekar, 2024).

India is multicultural and multilingual, and hence developmental auditory, speech, and language milestones may vary considerably concerning regional exposure to languages, cultural child-rearing traditions, as well as parental styles of interaction (Shonkoff & Miesles, 2000; Kelly, 2006). Ertem et al (2018) have emphasized that although developmental milestones universally develop at almost similar ages, cultural practices and linguistic background may influence the age of attainment of specific milestones. Thus, even when these kinds of tools can be useful across populations, there is a critical need for culturally and linguistically matched video references that are suitable for the Indian population to provide proper parental counselling on typical developmental milestones and thereby promote early identification and intervention.

1.3 Aim of the Study

To develop and validate a video-based visual library of auditory and speech behaviours of infants in the age range of 0-6 months, to enable parents to recognise typical developmental behaviours.

1.4 Objectives of the Study

1. To develop a comprehensive checklist consisting of age-appropriate auditory and linguistic behaviours of infants in the age range of 0-6 months, using the Delphi method through expert consensus from audiologists and speech-language pathologists.
2. To record videos of the identified behaviours in the checklists of infants having confirmed normal hearing.
3. To validate the recorded videos by providing them to parents to match the recorded videos with the behaviours listed in the checklist, and by professionals for identifying the video-recorded behaviours and matching them with age-appropriate groups.

Chapter 2

REVIEW OF LITERATURE

2.1 Need for Early Identification and Intervention of Childhood Hearing Loss

Hearing loss is one of the most prevalent congenital sensory disorders in children, which affects around 1-3 per 1000 newborns worldwide (WHO, 2021). According to WHO (2021), about 34 million children under 14 years (7% of the population) have hearing loss. The prevalence in India ranges between 1.59 and 8.8 per 1000 live births (Verma et al., 2022), which is higher than the global prevalence rate. According to WHO (2017) global estimates, the annual cost of unaddressed hearing loss ranges between $750 and $790 billion, which includes healthcare expenditures, education, loss of workplace productivity and broader societal costs. The global burden of congenital hearing loss is the question remaining about the possibility and means of enduring earliest identification of hearing loss.

Studies have tried to understand various aspects that can help reduce this global financial impact. One particular aspect studied in this direction was the impact of the age of intervention on children's language development. A study done by Yoshinago-Itano et al. (1998) found that the language outcomes of 72 children who were identified and intervened before 6 months of age were significantly better than those identified later, regardless of their degree of hearing loss, socioeconomic status and cognitive ability. Children who were identified after 6 months of age showed delayed vocabulary development, poor receptive and expressive language skills and reduced speech intelligibility. Moeller (2000) did a study on 112 children with hearing loss and found that those who were enrolled in intervention at a later age showed poor vocabulary and verbal reasoning skills when compared to those children who were enrolled earlier by 11 months of age. A survey by Constantinescu-

Sharpe et al (2017) of parents of hearing-impaired children, with a mean age of intervention of 0.84 years, indicated that these children were comparable to typically developing peers in terms of education and social interaction.

On the other hand, since the auditory cortex undergoes rapid development during the first years of life, prolonged auditory deprivation can result in cortical reorganization that can affect the further processing of auditory stimuli in the brain (Kral & Sharma, 2012). When hearing loss goes undetected, it can severely affect speech, language, cognitive, and emotional development in children (Yoshinaga-Itano, 2014), while normal language development in children with hearing loss can lead to integration into the mainstream educational and social environment (Constantinescu-Sharpe et al., 2017).

Before the universal screening program was implemented, the average age of identification of congenital hearing loss was 2.5 to 3 years in many countries (Mehl & Thomson, 1998), by which time auditory and language development in children would already have been compromised. After the implementation of UNHS, many countries were able to reduce the age of identification to within the first few months of life and carry out timely intervention before 6 months of age, leading to better speech, language and cognitive outcomes in children (Ching & Leigh, 2020).

The findings from the literature suggest that early identification and intervention are necessary to mitigate the adverse effects of congenital and early-onset hearing loss, and that implementing the NHS can significantly lower the age for early hearing loss detection and intervention.

The JCIH (2007) position statement has set the 1-3-6 timeline for early hearing loss detection and intervention: identification by 1 month of age, diagnosis by 3 months, and intervention by 6 months of age. This guideline was revised in 2019 by

JCIH to achieve the 1-2-3 benchmark in countries where the 1-3-6 benchmark has already been achieved. A randomized controlled trial by Kennedy et al. (2007) confirmed that infants screened under the UNHS program had better language outcomes by school age than non-screened infants. In the USA, 50% of babies screened were identified within 3 months of age, and 44.3% of these babies were intervened upon within 6 months of age (Deng et al., 2020). In many countries, following UNHS programmes could successfully reduce the mean age of identification to below 3 months of age (Kennedy et al., 2007).

A study done by Deng et al. (2020) in the United States reveals that even though 98% of the infants were screened using newborn hearing screening, only 50% of the referred babies from screening were diagnosed within 3 months of age and out of which only 44.3% of infants were intervened within 6 months of age. Despite strong evidence of the importance of early identification and intervention, approximately 50% of infants who fail hearing screening in the United States are not being timely followed up and diagnosed early (White et al., 2010).

2.1.1 Early Identification and Intervention: Indian Scenario

An established NHS program is an important factor that leads to early identification and intervention of congenital hearing loss. A study done by Neumann et al. (2020) found that less than 1% of newborn babies in India undergo hearing screening. The main reason behind this lower screening rate is the lack of a national mandate for the NHS. Among the health programs in India, the National Program for Prevention and Control of Deafness (NPPCD) (MOHFW, 2016) is exclusively for hearing loss, and the Rashtriya Bal Swasthya Karyakram (MOHFW, Government of India, 2013) looks at paediatric health holistically. Despite this, neither of the programs has been able to effectively implement UNHS across the country. Even

though different NHS protocols and programmes exist in the country, there is a lack of uniformity among the NHS protocols in India, and the referral and national follow-up rates also vary significantly across these protocols (Ramkumar, 2017).

Studies have also reported that several factors, like stigma, socio-economic status, limited access to health care and low parental awareness, will delay the diagnosis and intervention even when the child is being screened and referred for detailed evaluations (Merugumala et al., 2017; Pazhayapisharath & Maruthy, 2024; Ravi et al., 2016). As per the report of Manchaiah et al. (2010), the ratio of audiologists available to the public is 1:9, 50,000. This can affect the full-scale implementation of the UNHS program. In addition, studies also report a lack of awareness and training among primary and secondary health care providers regarding newborn hearing screening (Kumar & Mohapatra, 2011).

Due to these factors, a major population of children born with hearing loss in India does not undergo hearing screening and is identified later. Consequently, in the Indian context, the average age at which hearing loss is identified is around 2-3 years (Ravi et al., 2017), which is well beyond the JCIH benchmark. A qualitative study done in Karnataka found that the median age of suspicion of hearing loss by parents was 18 months, the age of diagnosis was 24 months, and the age of intervention was 30 months. The study also revealed that less than 4% of the children were diagnosed before three months, and less than 1% received intervention before 6 months of age (Pazhayapisharath & Maruthy, 2024). These findings highlight that there is an alarming gap and deficiencies in early identification and intervention of hearing loss in India.

2.2 Importance of Monitoring of Speech and Language Milestones in Children

While the NHS is proven to improve the age of identification and intervention of congenital hearing loss, it does have some caveats. Firstly, OAE screening is the most commonly used tool for newborn hearing screening due to its non-invasive nature, cost-effectiveness and speed. It measures the responses from the outer hair cells of the cochlea when the stimulus is presented. It therefore assesses function only up to the level of the cochlea (Kemp, 2002). This will lead to the under identification of conditions like retro cochlear pathology, auditory neuropathy spectrum disorder, in which the cochlea will be functioning normally while the neural functioning will be affected (Berlin et al., 2010). Secondly, OAE screening is not sensitive for detecting minimal-mild hearing losses, defined as a threshold between 15 and 40 dBHL, which may therefore be missed during NHS. Even minimal to mild degrees of hearing loss that are often missed by OAE screening can have a significant effect on speech perception, phonological development, and academic performance (Bess et al., 1998). Hence, relying solely on the pass/refer criterion of OAE screening results in false reassurance among clinicians and parents, delaying early identification and intervention in the cases that may be missed during the NHS process (Prieve & Stevens, 2000).

Newborn hearing screening may also not be able to detect progressive hearing loss or postnatal hearing loss, which may develop due to genetic, environmental or infectious causes. Non-congenital hearing losses resulting from infections like cytomegalovirus (CMV), meningitis, ototoxic medicine exposure or recurrent otitis media can affect hearing, which will not be detected by newborn hearing screening (Fowler et al., 1999). Therefore, a single newborn hearing screening at birth does not guarantee normal hearing throughout childhood. Even when universal newborn

hearing screening is widely accepted and promoted, passing the NHS does not guarantee that the child will have normal hearing throughout childhood; hence, ongoing developmental monitoring of auditory and speech milestones becomes relevant (JCIH, 2019).

2.2.1 Role of Parents in Early Identification of Behavioural Deviations

A systematic review of 10 studies across four continents, done by Gandini et al. (2024), has examined the methods and key implementers involved in monitoring the growth and development of toddlers. The study found that parents are effective monitors of developmental milestones in children, as they are the closest observers of their children's behaviours and serve as the primary mode of early education and stimulation. It was also found that parental educational programs on developmental milestones were found to improve the child's cognition, language and motor development, thus signifying the importance of parental engagement in developmental trajectories.

Research shows that parental concerns about a child's hearing and speech-language development are an indicator for professional evaluation, as parents are most often the first to notice deviations from the developmental trajectories (Glascoe, 1999). Parents who are aware of the milestones are more likely to report the concerns early, thereby identifying and intervening in the condition without further delays (Choo et al., 2019). JCIH (2019) also considers parental concern as a major criterion for audiological referral, regardless of results of any screening tests, highlighting the importance of parental monitoring of developmental milestones. Hence, parents and primary caregivers play a vital role in monitoring the auditory and speech milestones as they are the most consistent observers of the child's behaviour across all natural settings and developmental contexts. Consequently, they

can identify and report any deviations in the behaviours that can lead to early identification of hearing loss.

Considering the limitations of OAE screening and the significant role of parental monitoring of milestones in early detection of deviations, professional authorities have advocated for a comprehensive, longitudinal approach for monitoring the speech and language milestones, which should extend beyond the newborn period. JCIH (2019) recommends ongoing surveillance of auditory and speech milestones during well-child visits and to perform a detailed audiological evaluation when there is parental concern. The AAP also mandates ongoing hearing and communication surveillance with formal standardized screening at 9, 18, and 24 or 30 months of age. The CDC, through its "Learn the Signs. Act Early" program, also promotes ongoing developmental monitoring by providing milestone checklists and reference videos to parents and health care providers. ASHA also advocates continuous longitudinal monitoring of speech, language and auditory milestones throughout early childhood and affirms that parental concern alone is sufficient for conducting a comprehensive hearing and speech-language assessment. ASHA promotes a risk-based monitoring framework in which children with identified risk for developing late-onset or progressive hearing loss are flagged for more frequent audiological follow-up.

2.2.2 Help-seeking Behaviours of Parents

A qualitative study conducted on 35 parents having children with hearing loss done in Karnataka, India have identified 30 factors that contribute to the help-seeking behaviours of parents, which were classified into domains: awareness about hearing loss, geographical location, socio-economic status, family dynamics, and societal influences, and found that these factors differed significantly between early

and late help-seekers (Pazhayapisharath & Maruthy, 2024). Among these factors that contribute more to help-seeking behaviours are affordability, accessibility, and awareness, and the authors recommend enhanced public awareness, implementation of newborn hearing screening, and measures to make healthcare more accessible as key solutions to reduce the age of diagnosis of hearing impairment in India. Indian research also found that around 80% of the parents denied their child's hearing loss even after a formal diagnosis, and only 20% accepted hearing loss, and only 50% of the individuals received economic and emotional support following diagnosis (Deshpande & Bhogade, 2022). The stigma associated with the diagnosis of hearing loss and wearing of hearing devices, along with negative attitudes, poor parental knowledge, religious and cultural beliefs, together contribute to the late identification and intervention of hearing loss (Ravi et al., 2017). The importance of attitudinal and belief-based factors in influencing help-seeking behaviour is demonstrated by the higher perceived susceptibility to hearing loss, lower perceived barriers to rehabilitation, and stronger cues to action reported by parents and individuals seeking hearing help compared to those who do not (Knoetze et al., 2023).

Hence, parental help-seeking behaviours play a major role in the early identification and intervention of hearing loss, particularly during the initial stages of development, when parents are the key monitors of developmental milestones (Zaidman-Zait & Most, 2005). In most developing countries, such as India, where newborn hearing screening is not fully implemented, parents play a major role in suspecting delays in auditory and speech-language milestones in children and in seeking professional evaluation (Olusanya et al., 2014).

There is a strong correlation between the age of suspicion, the age of diagnosis, and the age of intervention. Age of suspicion significantly predicts age of

diagnosis and age of intervention. Therefore, early suspicion of hearing loss results in early identification and intervention. However, there is a three-month gap between the age of suspicion, the age of diagnosis and the age of intervention. Delays in parental help-seeking behaviours can lead to delayed identification and intervention, which can have a significant impact on a child's language, social, cognitive and academic development (Pazhayapisharath & Maruthy, 2024).

2.2.3 Lack of parental awareness of monitoring developmental milestones

A survey was conducted on awareness of developmental milestones in Alberta, Canada, on individuals who had interacted with children including parents under 14 years of age for the past 6 months and found that only 63% of individuals were able to answer half of the questions on physical development, 15% on cognitive development, 7% on social development and 2% on emotional development (Rikhy et al., 2010). A large cross-sectional study conducted in Riyadh, Saudi Arabia, on 1471 parents about the awareness of developmental domains found that 80% of the parents had poor knowledge of developmental milestones (Aldayel et al., 2020). A replication of the study was done by Habbash et al. (2022) in Aseer, Saudi Arabia and found that only 7.7 % of the 375 parents had excellent knowledge on developmental milestones, as defined by scoring above 75% on a 17-item questionnaire to assess parental knowledge on milestones. In a study done by Kumar et al. (2024), they found that less than one out of three parents surveyed is aware of the correct age at which the child should respond when called their name, but around two-thirds of the parents knew the age at which the first word should emerge and have a comprehension of 50 words.

A few of the Indian studies also demonstrated the same pattern of lack of parental awareness of milestones. A survey conducted by Pallavi and Waknis (2021)

on 80 parents of children with moderate-severe hearing loss, using a 20-item questionnaire, in New Delhi and Pune, found that awareness was moderate on speech and language milestones from birth to 3 years, and there was low to moderate awareness of the pragmatic use of language. Also, in the study, it was noted that parents of children who had already been fitted with hearing aids and were attending auditory therapy did not show a significant difference in awareness compared with parents of newly diagnosed children, suggesting that routine therapy did not improve their awareness of developmental milestones. A study conducted by Nagaria et al (2024) found that only 41.66% of young mothers were aware of language milestones, highlighting the need for structured and repeated parental education. In South India, a study conducted by Varghese et al. (2020) interviewed 156 mothers having children less than 5 years old using a 36-item questionnaire which consisted of 4 items regarding the risk factors associated with delayed milestones and 32 items to assess the awareness of parents on early childhood developmental milestones and found that the mean score was 12.4 out of 36, with more deficits in early milestones of speech and communication skills. A more recent study done by Nagaria et al. (2024) found that parents are aware of the gross developmental milestones but are less certain of milestones like babbling, word production and sentence usage, which highlights the importance of organizing awareness programmes at the village level. A qualitative study in Odisha district has also found that pregnant women and newborn mothers are rarely able to identify perinatal risk factors, missed newborn hearing screening and speech-language delays, thus highlighting the need for early anticipatory guidance (Sahoo et al., 2021)

Two observations stand out from these surveys. One, parental awareness regarding developmental milestones is poor across the globe. Second, parents have

more knowledge and are aware of domains like motor and physical development, in which the milestones are concrete and easily observable, while parents have poorer knowledge in speech and language, cognitive, emotional and social domains, in which the milestones are subtle and are not easily observable (Aldayel et al., 2020; Habbash et al., 2022; Rikhy et al., 2010).

Higher maternal education and prior health education by communication workers are associated with better scores (Varghese et al., 2020). A review of 260 peer-reviewed sources by Child Trends in the United States concluded that many first-time parents wanted to gain knowledge about developmental milestones; however, they could not access clear, trustworthy, and actionable information (Bartlett et al., 2018).

Considering the international and national studies, there is a lack of awareness among parents on auditory and speech-language milestones, which are the earliest cues to detect hearing loss and neurodevelopmental disorders (Bartlett et al., 2018; R. Kumar et al., 2024; Rikhy et al., 2010). Hence, there is a need to provide culturally adapted counselling to parents and caregivers on the importance of tracking the developmental milestones and the need for early detection and intervention.

A randomized clinical trial done in Brazil has found that when parent-based intervention covering aspects like auditory stimulation, social interaction and communication responsiveness was given for preterm infants starting from the neonatal care unit have significantly reduced the language delay from 4 through 18 months of corrected age when compared to those who were not given any special training (Silveira et al., 2024). A study conducted by Lee et al (2024) has recommended that when group-based counselling sessions were provided, including auditory stimulation, toy-tracking, caregiver-child interactions, and occupational

therapy components like eye contact, these factors have contributed to addressing the foundational precursors of speech and language development among parents and led to significantly higher receptive language scores at 24 months in the counseled group.

Therefore, parental counselling on developmental milestones, especially auditory and speech-language milestones is necessary, given parents' limited awareness of these domains. Primary health care providers should not only counsel on the milestones but also on the early warning signs and when to consult a professional (Rupert et al., 2023). More intensive counselling needs to be provided for parents having high-risk babies, especially those born pre-term, since the probability of getting a developmental delay is high in these infants (Lee et al., 2024). Also, it is important to counsel on the early auditory and speech milestones that develop before 6 months of age, so that early identification and intervention can be implemented (Nagaria et al., 2024). The primary health care physician should educate parents about auditory and speech-language milestones on a full spectrum, from responding to loud sounds at birth and head turn to sounds to babbling and the production of words, so that parents can serve as first-line observers between clinical visits (Liang et al., 2023). Parents also need to be made aware that whenever they suspect a delay in milestones, they should consult professionals such as audiologists and speech-language pathologists as soon as possible, given the critical window for speech and language development (McLaughlin, 2011).

2.3 Tools for Counselling Regarding Developmental Milestones

For effective counselling of parents, there needs to be structured, culturally appropriate and validated tools. These can include checklists, questionnaires,

applications and video-based modules. A systematic review and meta-analysis of 67 screening tools for language disorders found that parent-reported screening tools had a sensitivity of 81% and were comparable to clinician-assessment tools; hence, they can be used for parental counselling as well (So & To, 2022).

The CDC Milestone Checklist is an easy-to-use, evidence-based tool that can assist parents and caregivers in monitoring their child's development across important areas, such as speech, language, and hearing. This checklist provides normal developmental milestones of children in the age range of 2 months to 5 years, which allows easier identification of normal development patterns and promotes early detection of developmental delays (Abercrombie et al., 2022; Zubler et al., 2022). This is the focal point of the CDC's "Learn the Signs - Act Early" campaign, which focuses on improving early detection of developmental disability (CDC, 2022). CDC has also developed an interactive milestone tracker application with appropriate videos for parents and caregivers to regularly track developmental milestones.

The Ages and Stages Questionnaire Third Edition (ASQ-3) is also a widely accepted parental screening tool that assesses four domains, including speech and language, for children aged 0-5.5 years. The Communication and Symbolic Behaviour Scales Developmental Profile (CSBS-DP) is a validated parental screening tool for children aged 6 to 24 months that mostly targets pre-linguistic communication behaviours, including eye gaze, gesture, sound, and word and has been widely used in early identification programs (Wetherby & Prizant, 2002). The ASHA has also published a checklist freely available online that specifies the speech and language milestones to be achieved from birth to 5 years of age and provides a comprehensive basis for parental counselling and referral decision-making (ASHA, 2023).

In India, there are also various culturally adapted tools for parental counselling and enhancing awareness among parents on auditory, speech, and language milestones. The TDSC (Trivandrum Development Screening Chart) used in the age range of 0-6 years is validated on a sample of 1183 children against the Denver Developmental Screening Test and found a sensitivity of 90.8% (Nair et al., 2013). Complementary to TDSC, the Language Evaluation Scale Trivandrum for 0–3 years (LEST 0–3) is a 33-item questionnaire that specifically focuses on the language skills have found to have a sensitivity of 95.85% and specificity of 77.5% (Nair et al., 2013). The LittleEARS Auditory Questionnaire (LEAQ) is specifically designed for tracking preauditory milestones up to 24 months, which has been validated in Hindi (Prakash et al., 2023). The Ages and Stages Questionnaire Third Edition (ASQ-3) has been adapted into Hindi and validated at AIIMS New Delhi in 568 at-risk children aged 2–24 months and found a sensitivity of 95.9% and specificity of 81.7% (Gulati et al., 2023). However, in the Indian population, a video-based module or application like the CDC milestone tracker is not available to-date, which is highly required for parental awareness and for counselling.

2.3.1 Video-Based Modules for Counselling Parents

A systematic review and meta-analysis by Morgado et al. (2024) included 40 studies and found that video-based learning across different health education settings had a significant effect on knowledge acquisition and a moderate effect on attitude change. Xiao et al. (2024), in a systematic review of 54 video health-promotion studies, found that video-based tools are effective in modifying health-related behaviours, attitudes and intentions and also highlighted that narrative videos help in promoting protective caregiving practices. A study done by Donkor

(2010) found that video-based materials resulted in enhanced knowledge and greater learner satisfaction when compared with printed materials.

A quasi-experimental study conducted by Istiqomah et al. (2025) in Surakarta, Indonesia, in which 20 mothers were trained using videos on developmental stimulation, and after 2 weeks of training, it was found that the developmental scores of the children, as measured using Kuesioner Pra-Skrining Perkembangan (KPSP), increased from 40% at the baseline to 85%. A study conducted by Karama et al. (2022) provided video-based training to young mothers in Delhi-NCR and found that the mean post-test scores significantly increased from 4.94 to 11.17 out of a total score of 12. Rasheed et al. (2022) conducted a study in the same region to evaluate the effectiveness of a virtual education programme in improving developmental milestones awareness among parents and found that the post-test mean scores increased to 86.83% from a pre-test mean score of 77.50%.

Hence, video-based learning will be more beneficial in educating parents on developmental milestones, as these behaviours are inherently dynamic and are more understandable through demonstration than through written materials alone (Herawaty, 2021). As per the Cognitive Theory of Multimedia Learning, when a person is using both auditory and visual sensory channels, it promotes better encoding of information and longer retention than using a single-channel print-based format (Morgado et al., 2024). Video counselling materials will allow parents to pause, replay and attend to the behaviours that were unnoticed, which is an advantage that cannot be made use of in verbal counselling (Smith et al., 2013). It can be used as an effective counselling tool since it allows parents to see the real videos of how these behaviours are seen in young children, which will allow them to form a clear mental picture and then compare it with their own children.

In summary, research shows that delayed identification and intervention of hearing loss can significantly affect the speech, language, cognitive, social and emotional development of a child. As in India, there is no nationwide NHS programme; the average age of identification in India is around 2.5 to 3 years. The NHS also has its own limitations in identifying mild hearing loss, progressive hearing loss, ANSD and postnatal hearing loss. In the Indian context, parental awareness of auditory and speech milestones is lower when compared to more observable motor milestones. Given these gaps, there is a strong need to develop structured and culturally appropriate counselling tools for parents, among which video-based modules are considered most effective. However, there are no such validated video tools available in Indian contexts for counselling and monitoring of speech and language milestones in children

Chapter 3

METHODS

The study was conducted to develop video references of auditory and speech behaviours of infants in the age range of 0-6 months for parental counselling, with the aim of helping parents to suspect hearing loss at an early stage and thereby promote early identification and intervention of hearing loss. The Institutional Ethical Board ethically approved the study (Ref: SH/IRB/M.4/AUD.38/2025-26) (Appendix 1). The study was carried out in three phases:

3.1 Phase I: Development of the behavioural checklist

3.2 Phase II: Video recording of the behaviours

3.3 Phase III: Validation of the recorded videos

3.1 Phase I - Development of the behavioural checklist

This step employed the Delphi method with two rounds, where the checklist was developed based on sequential input from a set of professionals. The steps, therefore, included

3.1.1 Formation of an expert panel

3.1.2 Round 1: Distribution of the questionnaire

3.1.3 Analysis of behaviours obtained in Round 1

3.1.4 Round 2: Assigning behaviours to different age ranges

3.1.5 Analysis of responses obtained from Round 2

3.1.5 Cross verification with the standardized checklists

3.1.6 Finalization of behaviours

3.1.1 Formation of the Expert Panel

An expert panel was formed with professionals consisting of four audiologists and four speech-language pathologists with at least one year of experience working with the pediatric population. The professionals recruited were clinical staff, who had worked in the POCD department of AIISH, Mysuru, as well as from external sources through personal professional contacts. Professionals recruited had either experience in working with the infant population or were exclusively involved in the field of auditory training in children. Table 3.1 shows the distribution of professionals according to their affiliated centre.

Table 3.1

Distribution of Audiologists and Speech-Language Pathologists According to Their Affiliated Centres

Sl No.	Affiliated Centre	Audiologists	SLPs
1	All India Institute of Speech and Hearing (AIISH), Mysuru	2	2
2	National Institute of Speech and Hearing (NISH), Trivandrum, Kerala	1	1
3	Bharati Vidyapeeth, Pune	1	0
4	KIMS Hospital, Trivandrum, Kerala	0	1

The professionals were contacted via Gmail and text messages to inform them about the study and to confirm their participation. They were also informed that the study will be conducted using the Delphi method with 2-3 rounds, and hence, they might have to give their professional input multiple times, which will be collected through online mode.

3.1.2 Delphi Round 1: Distribution of the Questionnaire

Google Forms sent through Gmail and text messages were used to collect inputs from professionals. Demographic details of the professionals collected included name, qualification, designation and years of experience working with the paediatric population. The demographic details of the professionals included in the study are depicted in Table 3.2

Table 3.2

Demographic Details of the Professionals Included in Phase 1 of the Study

Professional	Qualification	Designation	Years of Experience
1	Msc Audiology	Audiologist	2
2	Msc Audiology	Assistant Professor	8
3	Msc Audiology	Audiologist	1
4	Msc Audiology	Audiologist Grade 1	3.5
5	Msc SLP	Assistant Professor	7
6	Msc SLP	Speech Therapist	4
7	Msc SLP	SLP	3
8	Msc SLP	SLP	5

After a brief explanation of the purpose of the form, it included video references and collected input from professionals. There were two video references included, depicting auditory and speech behaviours of infants in the age range of 0-6 months, which were taken from the CDC milestone tracker app, which would help the professionals to get a clear picture of the videos that are meant to be recorded in the study.

After this, professionals were instructed to list 2-3 observable behaviours that can be video-recorded, similar to those from the CDC application, separately for the

auditory and speech domains, across the age ranges of 0-2, 2-4, and 4-6 months. For example, one of the instructions provided was "List 2-3 auditory behaviours of infants in the age range of 0-2 months that are easily observable and can be video recorded". Similar instructions were repeated for speech behaviours and across different age groups of 0-2, 2-4 and 4-6 months.

3.1.3 Analysis of Responses Obtained from Round 1

The responses obtained from Round 1 included auditory and speech behaviours, collected separately for the age ranges 0-2, 2-4, and 4-6 months. The behaviours commonly listed by professionals were grouped into a single behavioural category. Behaviours that overlapped across multiple age ranges were listed under the relevant age ranges, based on the input from the professionals. Hence, the final output after analysis of responses from round 1 included auditory and speech behaviours listed by the professionals, categorized into age ranges: 0-2, 2-4, and 4-6 months.

3.1.4 Round 2: Assigning Behaviours to Different Age Ranges

A pilot rating was conducted to determine how the Google Form in round 2 should be structured since there were many overlapping behaviours in round 1. Two Google Forms with different formats were created and sent to a professional experienced in the pediatric population who had not participated in round 1. The first format consisted of a 5-point rating scale form in which each behaviour obtained from round 1 was listed, and the professionals were asked to rate the age appropriateness of each behaviour based on the age ranges they had previously been assigned in Round 1. The expert was also asked to rate each behaviour based on the ease with which each behaviour can be recognized by a naive observer on a 5-point rating scale.

In the second format, behaviours obtained from round 1 were listed, and the professional was given multiple-choice questions to classify each behaviour into the age groups: 0-2, 2-4, and 4-6 months. The expert was allowed to select more than one age range wherever applicable.

Based on responses to these two Google Forms, it was found that the second format was more effective at identifying overlapping behaviours and classifying them into appropriate age groups; hence, round 2 proceeded with the second Google Form format.

While implementing Round 2, the piloted Google form was circulated among the professionals to classify the behaviours into the correct age groups. They were allowed to select more than one age range wherever applicable.

3.1.5 Analysis of Responses Obtained from Round 2

Frequency counts of auditory and speech behaviours assigned to the age ranges 0-2, 2-4, and 4-6 months by each professional were obtained to identify overlapping patterns of behaviours (if any) across the three age ranges. The age range assigned by the majority of professionals for each behaviour was used to classify the obtained behaviours into separate age groups. If the behaviours overlap across age ranges, necessary steps were taken to combine the overlapping age ranges.

3.1.6 Cross-verification with Existing Developmental Tools

The final pooled list of behaviours was compared against Indian standardized developmental checklists: Communication DEALL and the Assessment Checklist for Speech-Language Scale (ACSLS), and with the auditory and linguistic milestones provided in the CDC milestone tracker application. Those behaviours that were not

in compliance with these standardized checklists were removed from the final checklist.

3.1.7 Finalization of Behaviours

A final list of age-appropriate auditory, speech, and language behaviours was developed. Those behaviours that were difficult to video record were removed, and the behaviour checklist was finalized.

3.2 Phase 2: Video Recording of Behaviours

3.2.1 Participant Selection

A total of 9 participants were recruited for the study, aged 0-6 months. Among them, 5 participants belonged to the 0-2 months age group, and 4 participants belonged to the 3-6 months age group. The age details of participants are represented in Table 3.3. Participants were obtained through 3 ASHA workers in Nedumangadu and Anad Taluk in Trivandrum, Kerala, and their phone numbers were collected. Caregivers of the participants were contacted and informed regarding the study procedure.

Table 3.3

Age Details of the Infants Selected for Video Recording

Infants	Age (in months)	
	0-2 months	3-6 months
1	1.5	4
2	1.9	5
3	1.5	3.5
4	2	4.5
5	2	6

3.2.2 Inclusion Criteria

1. Confirmed normal hearing with bilateral OAE screening PASS/ diagnostic Auditory Brainstem Response (ABR), having well-defined peaks till 30 dBnHL.
2. Having typical developmental milestones, as confirmed with the Communication DEALL checklist
3. Parental consent obtained

3.2.3 Video Recording Set-Up

Auditory and speech behaviours listed in the checklist were video recorded by visiting the child's home. The recording room was ensured to be quiet and well-lit. Videos were recorded using an iPhone 12. A baby bed, a pacifier, and a tripod were carried during home visits to record the behaviours. A baby bed was used to make the infants lie on the floor and to ensure uniformity of the videos. The placement of the tripod and the distance of recording varied depending on the behaviour that needed to be recorded. In order to minimise the interference from background noise, the Digitech wireless microphone was clipped to the child's and the mother's clothes. This would enhance the voice of the infant and mother while reducing background noise interference.

To ensure consistency and standardization in eliciting and documenting behaviours in infants, an individual recording script was developed for every identified behaviour. The scripts included the stimulus presentation method, camera placement, recording angle, infant position and state and the expected response. The recording procedure and the stimulus used varied depending on the behaviour targeted. The scripts are provided in Appendix 2.

Before recording the videos, informed consent was obtained from the parents, stating that the videos would be used for public education and student training. Then videos were recorded for each behaviour, following the prepared scripts.

Since most of the behaviours that need to be video recorded require the infant's cooperation, the videos were recorded when the child was awake and active. Parents were contacted prior to the home visits and were asked about the infants' active periods, and visits were scheduled accordingly. However, most of the behaviours required multiple attempts and were highly dependent on the infant's state of awakeness. Around 2-5 hours were required for recording all the behaviours in a single child, including breaks provided for sleeping and feeding. For recording some behaviours, 2-3 home visits were required to elicit and capture the response accurately.

3.3 Phase 3: Validation of Recorded Videos

In this phase, the professionals and parents were asked to match the videos with the behaviours and to identify the age ranges in which these behaviours would occur. This was done to ensure that the videos recorded accurately represent the targeted behaviours and the assigned age ranges, and to check the parental awareness of the early auditory and speech milestones. This phase included the following steps

3.3.1 Professional validation of recorded videos

3.3.2 Data analysis of validation results by professionals

3.3.3 Parental validation of recorded videos

3.3.4 Data analysis of validation results by parents

3.3.1 Professional Validation of Recorded Videos

A different group of 4 audiologists and 4 speech-language pathologists, not included in phase 1, took part in the validation of the study. Professionals who had a minimum of one year of working experience with paediatric populations and had young children of their own were recruited from AIISH, Mysuru. The demographic details of the professionals are given in Table 3.3. They were provided with a Google Drive link containing 30 validation videos, numbered from 1 to 30. They were also provided with a list of behaviours arranged in a random order to match the videos. The professionals were instructed to watch the videos carefully and match the corresponding video number to the appropriate behaviour name while recording their responses. They were also instructed to classify the behaviours as falling into the age range of 0-2 or 3-6 months.

Table 3.4

Demographic Details of the Professionals in Validation of the Study

Professionals	Qualification	Designation	Years of experience
1	PhD (Audiology)	ASLP Grade 1	16
2	MSc SLP	Assistant Professor	14
3	PhD (Audiology)	Associate Professor in Audiology	23
4	PhD (Audiology)	ASLP Grade 1	15
5	PhD (SLP)	Lecturer in Speech Language Sciences	8
6	MSc (Audiology)	ASLP Grade 1	10
7	MSc (SLP)	ASLP Grade 2	10
8	PhD (SLP)	Assistant Professor	10

An equivalency rating was also conducted to check whether all three videos recorded equally represented the target behaviour. For this purpose, two professionals who were not previously included in the study were recruited. They

were provided with a Google Drive link containing all 30 videos, each numbered 1-30. They were also given a Google form containing a Likert scale from 1 to 5 to rate how accurately each video represents the target behaviour. The instruction given was as follows: "Please watch each video carefully and rate how well the behaviour named is represented in the video. The video numbers are provided under each behaviour; please watch each video and rate it based on the representation of the behaviour mentioned. Use a rating scale from 1 to 5 to rate the videos, as per the Likert scale given below:

The 5-point Likert scale given for rating was as follows

1- Behaviour is not represented at all

2- Behaviour is slightly represented

3- Behaviour is moderately represented

4- Behaviour is strongly represented

5- Behaviour is very strongly represented

3.3.2 Data Analysis of Validation Results by Professionals

The percentage accuracy of matching the videos with the appropriate behaviours from the checklist and the percentage accuracy of matching the age range of the behaviours were calculated. The videos were considered true representations of the behaviours if the matching accuracy was greater than 80%. Similarly, age ranges were considered to be correctly assigned to the behaviours if the age-range matching accuracy was greater than 80%.

For the equivalency rating, videos rated 3 or higher were considered to accurately represent the target behaviour and therefore equivalent.

3.3.3 Parental Validation of Recorded Videos

A total of 5 parents with infants aged 6 months who had passed the NHS and had normal hearing were recruited through personal contacts to validate the recorded videos. They were provided with the task of matching the recorded videos with the appropriate behaviours mentioned in the checklist. Participants were provided with a Google Drive link containing 30 validation videos, numbered from 1 to 30. They were also provided with a list of behaviours arranged in a random order to match with the videos. The parents were instructed to watch the videos carefully and match the corresponding video number to the appropriate behaviours while recording their responses. They were also instructed to classify the behaviours as falling into the age range of 0-2 or 3-6 months based on their observation of their child. Translation of the description of behaviours mentioned in the checklist to their native language was provided if necessary.

3.3.4 Data Analysis of Validation Results by Parents

The percentage accuracy of matching the videos with the appropriate behaviours from the checklist and the percentage accuracy of matching the age range of the behaviours were calculated. Parents who had more than 80% accuracy in matching both behaviours and their corresponding age ranges were considered to be aware of the behaviours and the age ranges in which they occur.

Chapter 4

RESULTS

The aim of the study was to develop and validate a video-based visual library of auditory and speech behaviours of infants in the age range of 0-2, 2-4, and 4-6 months, to enable parents to recognize typical developmental behaviours. The results obtained in the study are discussed under the following headings:

4.1 Development of the Behavioural Checklist

4.2 Video Recording of the Behaviours

4.3 Validation of the Recorded Videos

4.1 Development of Behavioural Checklist

The input obtained from professionals through Delphi method were combined and compared with the standardized checklists to develop the final behavioural checklist. The results under this section will be discussed under the following headings:

4.1.1 Analysis of Responses Obtained from Delphi Round 1

4.1.2 Analysis of Responses Obtained from Delphi Round 2

4.1.3 Cross-verification with Existing Developmental Tools

4.1.4 Finalization of Behaviours

4.1.1 Analysis of Responses Obtained from Delphi Round 1

The commonly listed auditory and speech behaviours by the professionals in round 1 of Delphi method were combined to form different behavioural categories. Tables 4.1 to 4.6 represents the auditory and speech behaviours listed by each professional separately for the age ranges 0-2, 2-4 and 4-6 months.

Table 4.1

Auditory behaviours under the age range of 0- 2 months listed by professionals. The green colour indicates the behaviour mentioned by the professional

Sl No.	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Responding to loud sounds								
2	Quieting/Calming on hearing a familiar voice								
3	Looking at the speaker while talking								

Table 4.2

Speech behaviours under the age range of 0- 2 months listed by professionals. The green colour indicates the behaviour mentioned by corresponding professional

Sl. No	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Crying to express needs								
2	Differential Cry								
3	Cooing								
4	Vegetative Sounds								

Table 4.3

Auditory behaviours under the age range of 2-4 months listed by professionals. The green colour indicates the behaviour mentioned by the professional

Sl. No	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Responding to loud sounds								
2	Smiling in response to familiar voice								
3	Turning head towards lateral side on hearing a familiar voice/sounds								
4	Responding to musical tones/Showing interest in musical tones								
5	Quieting/Calming on hearing a familiar voice								

Table 4.4

Speech behaviours under the age range of 2-4 months listed by professionals. The green colour indicates the bheaviour mentioned by corresponding professional

Sl No.	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Cooing								
2	Differential Cry								
3	Vocalizing back to the caregiver while speaking								

Table 4.5

Auditory behaviours under the age range of 4-6 months listed by professionals. The green colour indicates the behaviour mentioned by the professional

Sl No.	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Turning head towards lateral sides on hearing familiar voice/sounds								
2	Responding to musical tones/Showing interest in musical tones								
3	Smiling in response to familiar voice								
4	Quieting/Calming on hearing a familiar voice								

Table 4.6

Speech behaviours under the age range of 4-6 months listed by professionals. The green colour indicates the behaviour mentioned by corresponding professional

Sl No.	Behaviours	Professionals							
		1	2	3	4	5	6	7	8
1	Cooing								
2	Vocalizing back to the caregiver								
3	Babbling								
4	Imitating lip movements								

Based on the responses obtained from professionals the most commonly reported auditory behaviours for the age range 0-6 months were “Responding to loud sounds”, followed by “Turning head towards lateral side on hearing a familiar voice/sounds”. In contrast, the least reported auditory behaviours were “Looking at the speaker while talking”, followed by “Smiling in response to caregiver’s voice” and “Quieting/calming on hearing a familiar voice”. The most commonly reported speech behaviours for the age range 0-6 months were “Cooing” followed by “Vocalizing back to the caregiver while talking” and “Differential cry”. The least reported speech behaviours were “Babbling” followed by “Imitating lip movements”.

The tables 4.1 to 4.6 clearly depicts that there is an overlap of behaviours among age ranges. The auditory behaviours listed under the age ranges 2-4 and 4-6 months are found to be similar. Most of the speech behaviours reported were also similar under 2-4 and 4-6 months with the exception of differential cry, which was listed only under 2–4 months, and babbling and imitating lip movements, which were listed only under the 4–6 months age range.

4.1.2 Analysis of Responses Obtained from Delphi Round 2

The frequency count of auditory and speech behaviour assignments across age ranges (0–2, 2–4, and 4–6 months) by eight professionals are depicted in Tables 4.7 and 4.8. These tables represent heat map illustrating the frequency count of age range assignments made by eight professionals for each auditory behaviour across three age ranges: 0–2, 2–4, and 4–6 months. Cell values represent the number of professionals (out of 8) who assigned a given behaviour to the respective age range.

The colour scale based on the frequency count given by professionals out of 8 is as follows:

Not assigned (0)	Low (1–2)	Moderate (3–4)	High (5–6)	Very High (7-8)

Table 4.7

Heat map of Frequency Count of Auditory Behaviour Assignments Across Age Ranges (0–2, 2–4, and 4–6 Months) by Professionals

Sl No.	Auditory Behaviours	0–2 months	2–4 months	4–6 months
1	Responding to loud sounds	**8**	**2**	0
2	Quieting/Calming on hearing a familiar voice	**3**	**6**	**8**
3	Looking at the speaker while talking	**6**	**3**	**2**
4	Smiling in response to familiar voice	**1**	**6**	**6**
5	Turning head towards lateral side on hearing a familiar voice/sounds	0	**7**	**8**
6	Responding to musical tones/Showing interest in musical tones	0	**5**	**6**

Table 4.8

Heat map of Frequency Count of Speech Behaviour Assignments Across Age Ranges (0–2, 2–4, and 4–6 Months) by Professionals

Sl No.	Behaviour	0–2 months	2–4 months	4–6 months
1	Cooing	**3**	**8**	**7**
2	Differential Cry	**6**	**3**	**1**
3	Crying to express needs	**8**	**5**	**3**
4	Vegetative sounds	**8**	**3**	**2**
5	Vocalizing back to the caregiver while talking	0	**6**	**8**
6	Babbling	0	0	**8**
7	Imitating lip movements	0	0	**8**

The frequency counts indicate an overlap of behaviours across the age ranges, with the exception of babbling and imitating lip movements, which were assigned exclusively to the 4-6 months age range with no overlap across the other age ranges. Behaviours such as smiling in response to a familiar voice, quieting/calming on hearing a familiar voice, turning head towards the lateral side on hearing familiar voice/sounds, cooing and vocalizing back to the caregiver while talking demonstrated a high overlap, with frequency counts of 5 and above, across the 2-4 and 4-6 months age ranges. Behaviours such as responding to loud sounds, looking at the speaker while talking, differential cry, vegetative sounds, and crying to express needs were

present across all three age ranges; however, the majority of frequency counts were concentrated in the 0-2 month's age range, with counts falling below 4 in the remaining age ranges. An exception to this was the behaviour crying to express needs, for which the frequency count is 8 for 0-2 months, 5 for 2-4 months and 1 for 4-6 months, indicating a high overlap across the age ranges 0-2 and 2-4 months.

Therefore, in order to classify the obtained behaviours into separate age ranges, the frequency counts of professional assignments for each behaviour were considered. The age range assigned by the majority of professionals for each behaviour was taken as the basis for classification. However, the behaviours identified across the age ranges 2-4 and 4-6 months age were same except for behaviours babbling and imitating lip movements, which were exclusively classified under 4-6 months age range. These age ranges also had a high overlap of frequency counts exceeding 5 out of a total of 8. Hence, the final behavioural checklist was developed by combining the behaviours of 2-4 and 4-6 months age ranges into a single age range of 3-6 months. Even though, the behaviour "crying to express needs" had a high overlap between 0-2 and 2-4 months age range, it was classified under 0-2 month's age range given that 8 out of 8 professionals assigned it to this age range.

4.1.3 Cross-verification with Existing Developmental Tools

The list of behaviours was verified by comparing them to standardized tools. The verification was done for both the behaviours and the age ranges they were assigned to. Table 4.9 shows the comparison of the obtained behaviours with the standardized checklists.

Table 4.9

Comparison of the Behaviours with the Standardized Checklists

Sl No.	Behaviours	Compliance with the standardized checklists
1	Responding to loud sounds	✓
2	Quieting/Calming on hearing a familiar voice	✓
3	Looking at the speaker while talking	✓
4	Smiling in response to familiar voice	✓
5	Turning head towards lateral side on hearing a familiar voice/sounds	✓
6	Responding to musical tones/Showing interest in musical tones	✓
7	Cooing	✓
8	Differential Cry	✓
9	Crying to express needs	✓
10	Vegetative sounds	✓
11	Vocalsing back to the caregiver while talking	✓
12	Babbling	✗
13	Imitating lip movements	✗

From Table 4.9 those behaviours that were in compliance with the standardized checklists were taken for the development of the final behavioural checklist. Behaviours such as babbling and imitating lip movements were removed as these behaviours occur after 6 months as per the standardized checklists. Even though babbling and imitating lip movements can emerge by 6 months, these behaviours may not be consistently present in the age range of 3-6 months and hence these behaviours were excluded from the final behavioural checklist.

In addition, the behavior differential cry was removed since it is difficult to be identified by a naive observer and difficult to be video recorded.

4.1.4 Final Behavioural Checklist

The final behavioural checklist developed had a total of ten behaviours with six auditory behaviours and four speech behaviours across the age ranges 0-2 and 3-6 months. Table 4.10 depicts the final auditory and speech behavioural checklist developed for the age ranges: 0-2 and 3- 6 months.

Table 4.10

Auditory and Speech Behavioural Checklist for the Age Ranges of 0-2 and 3-6 Months

Age Range	Auditory Behaviours	Speech Behaviours
0-2 months	Responding to loud sounds Looking at the speaker while talking	Crying to express needs Vegetative sounds
3-6 months	Smiling in response to caregiver's voice Quieting/Calming on hearing a familiar voice Turning head to lateral sides on hearing a familiar voice Responding to musical tones/showing interest in musical tones	Vocalizing back to the caregiver while speaking Cooing

4.2 Video Recording of Behaviours

Based on these scripts developed for each auditory and speech behaviour, videos were recorded in infants in the age range of 0-6 months. Three videos were recorded for each of the behaviour, hence making a total of 30 videos for ten behaviours. These videos were labeled and stored in the Google drive.

4.4 Validation of the Recorded Videos

The percentage accuracy of matching the videos with the targeted behaviours and percentage accuracy of matching the age ranges with each behaviour obtained from both professionals and parents are presented below.

4.4.1 Results of Validation by Professionals

Table 4.11 depicts the matching accuracy of videos with the behaviours by each professional. Results from Table 4.11 shows that professionals had more than 80% accuracy in matching the videos with the behaviours. Most of the videos had 100% matching accuracy, except for two videos: one corresponding to the behaviour *"Looking at the speaker while talking"* and another corresponding to *"Smiling in response to the caregiver's voice."*

Professionals were also asked to identify the age range in which the behaviours are usually observed after watching the videos. All the professionals had 100% accuracy in identifying the age ranges of the behaviours.

An equivalency rating was conducted to check whether the three video recorded for a single behaviour equally represent the targeted behaviour. Table 4.12 shows the equivalency rating of videos for the representation of the intended behaviours.

Table 4.11

Matching Accuracy of Videos with the Behaviours by Professionals

Sl No.	Behaviours	Video No.	Professionals								Percentage Accuracy
			1	2	3	4	5	6	7	8	
1	Responding to loud sounds	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
2	Looking at the speaker while talking	1	✗	✓	✓	✓	✓	✓	✓	✓	87.5%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
3	Crying to express needs	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
4	Vegetative sounds	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
5	Smiling in response to caregiver's voice	1	✗	✓	✓	✓	✓	✓	✓	✓	87.5%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
6	Quieting/Calming on hearing a familiar voice	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
7	Turning head to lateral sides on hearing a familiar voice	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
8	Responding to musical tones/showing interest in musical tones	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
9	Vocalising back to the caregiver while speaking	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%
10	Cooing	1	✓	✓	✓	✓	✓	✓	✓	✓	100%
		2	✓	✓	✓	✓	✓	✓	✓	✓	100%
		3	✓	✓	✓	✓	✓	✓	✓	✓	100%

Table 4.12

Equivalency Rating of Recorded Videos by Professionals

Sl No.	Behaviour	Video No.	Rater 1	Rater 2
1	Responding to loud sounds	1	4	5
		2	3	4
		3	4	5
2	Looking at the speaker while talking	1	5	4
		2	5	5
		3	5	5
3	Crying to express needs	1	5	4
		2	4	5
		3	5	4
4	Vegetative sounds	1	3	5
		2	4	5
		3	5	5
5	Smiling in response to caregiver's voice	1	4	4
		2	4	5
		3	3	3
6	Quieting/Calming on hearing a familiar voice	1	3	5
		2	5	5
		3	4	5
7	Turning head to lateral sides on hearing a familiar voice	1	5	5
		2	4	5
		3	4	4
8	Responding to musical tones/showing interest in musical tones	1	3	4
		2	4	5
		3	5	5
9	Vocalizing back to the caregiver while speaking	1	4	5
		2	4	5
		3	5	5
10	Cooing	1	4	4
		2	4	5
		3	5	5

Note. The rating was done on a 5 point likert scale where 1 indicates behaviour is not at all represented, 2 indicates behaviour is slightly represented, 3 indicates behaviour is moderately represented, 4 indicates behaviour is strongly represented and 5 indicates behaviour is very strongly represented.

During the equivalency rating (Table 4.12) all the videos were rated by professionals as 3 or above, indicating that the three videos recorded for each of the targeted behaviour were equivalent in their representations.

4.4.2 Results of Validation by Parents

The matching accuracy of videos with the behaviours by each parent is depicted in Table 4.13

Table 4.13

Matching Accuracy of Videos with the Behaviours by Parents

Sl No.	Age Range	Behaviours	Video No.	Parents					Percentage Accuracy
				1	2	3	4	5	
1	0-2 months	Responding to loud sounds	1	✓	✓	✗	✓	✓	80%
			2	✓	✓	✓	✓	✓	100%
			3	✓	✓	✓	✓	✓	100%
2	0-2 months	Looking at the speaker while talking	1	✓	✓	✓	✓	✗	80%
			2	✓	✓	✓	✗	✗	60%
			3	✓	✗	✓	✓	✗	60%
3	0-2 months	Crying to express needs	1	✓	✓	✓	✓	✗	80%
			2	✓	✓	✓	✗	✓	80%
			3	✓	✓	✓	✗	✓	80%
4	0-2 months	Vegetative sounds	1	✓	✓	✓	✓	✗	80%
			2	✓	✓	✓	✓	✓	100%
			3	✓	✓	✓	✓	✓	100%
5	3-6 months	Smiling in response to caregiver's voice	1	✗	✗	✓	✗	✗	20%
			2	✗	✓	✓	✗	✗	60%
			3	✓	✓	✓	✗	✗	60%
6	3-6 months	Quieting/Calming on hearing a familiar voice	1	✓	✗	✗	✗	✗	20%
			2	✗	✗	✓	✗	✓	40%
			3	✗	✓	✗	✗	✓	40%
7	3-6 months	Turning head to lateral sides on hearing a familiar voice	1	✓	✗	✓	✗	✗	20%
			2	✓	✓	✗	✓	✓	80%
			3	✓	✓	✗	✓	✓	80%
8	3-6 months	Responding to musical tones/showing interest in musical tones	1	✗	✓	✗	✓	✗	20%
			2	✓	✓	✓	✓	✓	100%
			3	✓	✓	✓	✗	✓	80%
9	3-6 months	Vocalizing back to the caregiver while speaking	1	✓	✗	✗	✗	✗	20%
			2	✗	✓	✓	✗	✓	60%
			3	✗	✗	✗	✗	✓	20%
10	3-6 months	Cooing	1	✗	✗	✗	✓	✗	20%
			2	✗	✓	✗	✗	✗	20%
			3	✗	✓	✓	✗	✗	40%

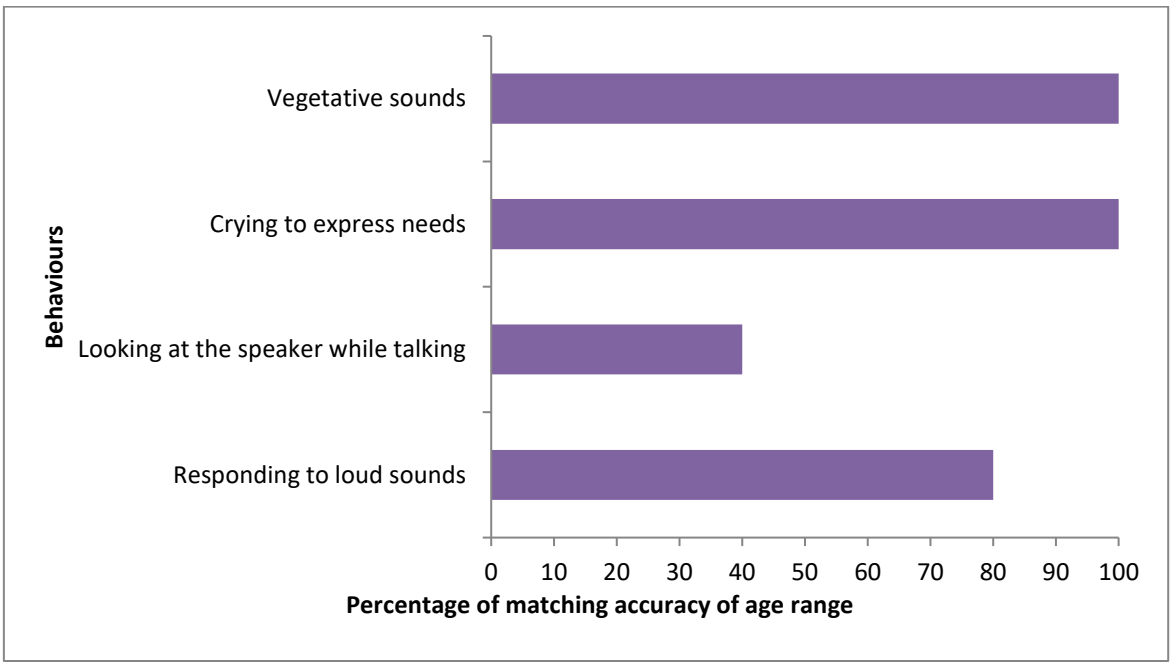
Results from Table 4.13 shows that matching percentage by parents for behaviours in the age range 0-2 months ranged from 60% to 100%, while for behaviours in the age range 3-6 months ranged from 20% to 100%. For videos in the age range of 0-2 months the matching accuracy was 100% for 4 videos, 80% for 6 videos and 60% for 2 videos. For videos in the age range of 3-6 months the matching accuracy was 100% for 1 video, 80% for 3 videos, 60% for 3 videos, 40% for 3 videos and 20% for 8 videos.

Behaviour wise analysis shows that, in the age ranges of 0-2 months, for the behaviour: “Looking at the speaker while talking” had a matching accuracy of less than 80%, while other behaviours had a matching accuracy of greater than or equal to 80%. However, in the age range of 3-6 months all the bheaviours had an overall matching accuracy of less than 80% with the lowest accuracy for the behaviour “Cooing”.

The matching accuracy of age range with the auditory and speech behaviours by parents is depicted Figures 4.1 and 4.2.

Figure 4.1

Matching Accuracy of Age Range by Parents for Behaviours in the Age Range 0-2 Months

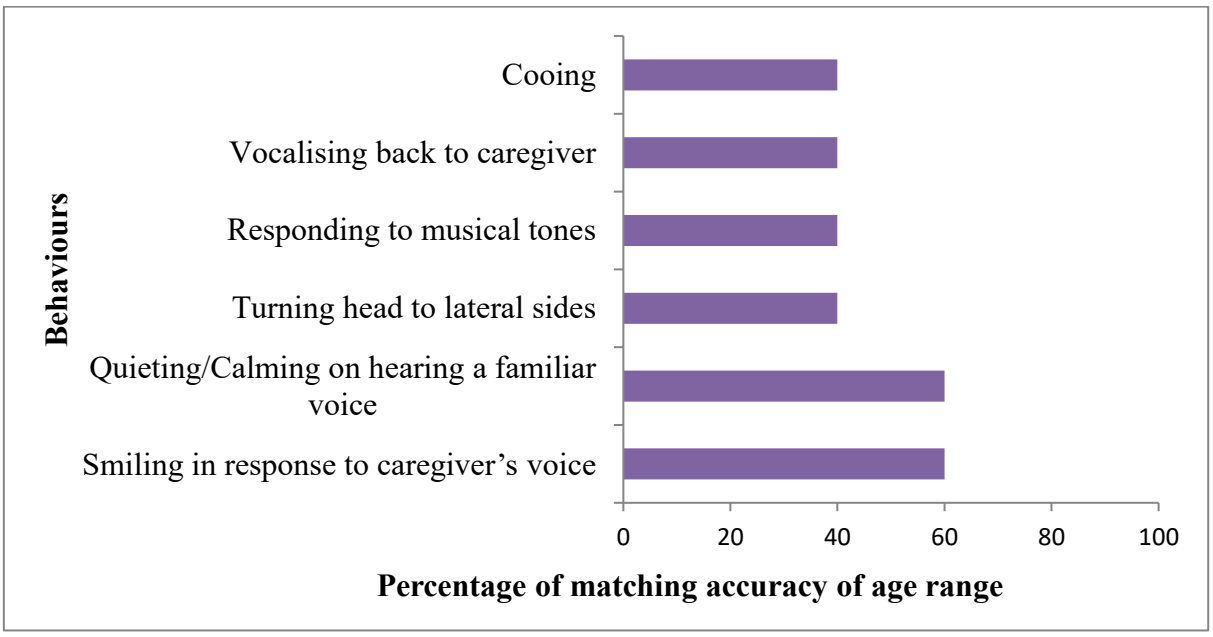


Note. The figure represents the percentage of matching accuracy of behaviours in the age range of 0-2 months by parents

The parental accuracy of assigning the age ranges for behaviours in the age range 0-2 months ranged from 40% to 100%. The behaviour "Looking at the speaker while talking" had the lowest matching accuracy of 40%, followed by the behaviour "Responding to loud sounds" with an accuracy of 80%. The behaviours: "Vegetative sounds" and "Crying to express needs" had a matching accuracy of 100%.

Figure 4.2

Matching Accuracy of Age Range by Parents for Behaviours in the Age Range 3-6 Months



Note. The figure represents the percentage of matching accuracy of behaviours in the age range of 0-2 months by parents

The parental accuracy of assigning the age ranges for behaviours in the age range 3-6 months ranged from 40% to 60%. For behaviours such as cooing, vocalizing back to the caregiver, responding to musical tones/showing interest in musical tones and turning to lateral sides on hearing a familiar voice, had a matching accutacy of 40%. While, for behaviours such as quieting/calming on hearing a familiar voice and smiling in response to caregiver's voice, had a matching accuracy of 60%.

The overall trend from Figure 4.1 and Figure 4.2 clearly shows that parents had poor accuracy in assigning age ranges in 3-6 months age group when compared to 0-2 month's age group.

Overall the results shows that professionals had high accuracy of more than 80 % in identifying the behaviours from the videos and 100% accuracy in identifying the age group of the behaviours, indicating that the recorded videos appropriately represent the intended behaviours and the age groups targeted. However, parents had low accuracy in identifying the behaviours from the videos (ranging from 20% to 100%) as well as in assigning the age groups (ranging from 40% to 100%). Parents had more difficulty in identifying the behaviours and assigning the age groups for the 3-6 months age range than 0-2 month's age range.

Chapter 5

DISCUSSION

Early intervention of childhood hearing loss is crucial to ensure optimal speech and language development in children. Newborn Hearing Screening (NHS) is an evidence-based practice that can help identify congenital hearing loss well within the first month of a child's life and thus facilitate timely intervention. However, NHS has its limitations. When NHS is universally implemented, it fails to identify minimal-mild hearing loss, progressive hearing loss, and late-onset hearing loss (Bess et al., 1998; Fowler et al., 1999). In countries where there is no structured or established NHS program, many babies with hearing loss will not be identified early. In either case, parents need to monitor their children's auditory and speech milestones to be able to suspect hearing loss early in their children to facilitate timely intervention. However, studies consistently show that there is a lack of awareness among parents regarding early auditory and speech milestones. This causes a significant delay in the identification of early-onset hearing loss. For example, a recent study done in Karnataka has found that the average age of suspicion of hearing loss in children is by 18 months, diagnosis is by 24 months, and intervention is by 30 months, which is well beyond the 1-3-6 guidelines proposed by the Joint Committee on Infant Hearing (JCIH) (Pazhayapisharath & Maruthy, 2024). This reflects the scenario in our country, where there is no NHS implemented - the responsibility of suspecting hearing loss sits squarely on the parents' shoulders.

Given that children intervened before 6 months of age have better outcomes, the delay in identification and intervention is a major public health concern. It also indicates a need for means to ensure that parents are equipped with information to identify deviations in a child's auditory and speech development well within the first

6 months of life. Considering this, the present study aimed to develop and validate a culturally appropriate, video-based library of auditory, speech and language milestones in children in the age range of 0-6 months for the Indian population, which would help parents to understand the typical early auditory and speech milestones and to seek professional help in case of absence or deviations from the standardized norms. The findings from the study are discussed under the following headings:

5.1 Development of the Behavioural Checklist

5.2 Video Recording of Behaviours

5.3 Validation of Recorded Videos

5.1 Development of the Behavioural Checklist

The first objective of the study was to develop a comprehensive checklist of age-appropriate auditory and linguistic behaviours using the Delphi method through expert consensus from audiologists and speech-language pathologists. Even though many checklists to monitor auditory, speech and language milestones are available, most of them are developed in the Western context and are not culturally and linguistically adapted for the Indian population. The checklists currently available for the Indian population, like Communication DEALL, cover a broader developmental range and mostly focus on higher speech and language skills that develop after 1 year of age. Additionally, there was a need to list those behaviours that can be video-recorded and easily observed, for the purpose of the study. The major observations from the process of developing the behavioural checklist are discussed below.

5.1.1 Analysis of Responses Obtained from Professionals

The most commonly reported auditory and speech behaviours by professionals for the age range 0-6 months were – responding to loud sounds, turning head towards the lateral side on hearing a familiar voice, cooing, vocalizing back to the caregiver and differential cry. The least reported behaviours were – smiling in response to the caregiver's voice, quieting/calming on hearing a familiar voice, babbling and imitating lip movements. The most commonly reported behaviours were overt and easily observable, which explains the higher reporting frequency among professionals. In contrast, the least reported behaviours were subtle and could be considered difficult to identify. Also, the behaviours such as babbling and imitating lip movements are more consistently present after 6 months of age, even though these behaviours may emerge during the 4-6 month period. This may have led to the lowest reporting frequency count for these behaviours.

A significant finding during the construction of the checklist was that auditory and speech behaviours obtained from professionals in 2-4 and 4-6 months were overlapping. The number of reports by professionals of the behaviours "Cooing", "Vocalizing back to the caregiver while talking", "Quieting/Calming on hearing a familiar voice", "Smiling in response to familiar voice" and "Turning head towards lateral side on hearing a familiar voice/sounds" were reported 5 or more times out of a total of 8 in both 2-4 and 4-6 months age groups. This indicates an overlap of behaviours across these two age ranges. This is understandable, as according to NIDCD (2022), infants follow a natural progression in the attainment of auditory and speech milestones, and there is individual variability in the pace of their attainment. Hence, these overlapping behaviours do not exclusively belong to a single age range, but rather emerge during the 2-4 months period and persist into the 4-6

months period. In other words, these behaviours follow a developmental continuum rather than following distinct age-specific milestones. These findings highlight that infants' auditory, speech, and language development follows a continuous, ongoing trajectory, and hence it is difficult to classify these behaviours into narrow, distinct age ranges. Nevertheless, one can observe the behaviours even though they may not be assigned to narrow age ranges. For the same reason, professionals in the study have classified the same behaviours into different age groups, thus creating an overlap of these behaviours. To reliably classify behaviours into different age ranges for the purpose of this study, behaviours under 2-4 and 4-6 months were combined into a single age range of 3-6 months. This arrangement considers the natural variability among the children in their developmental milestones.

5.1.2 Cross-verification with Existing Developmental Tools

The listed behaviours by professionals were cross-verified with standardized tools, namely Communication DEALL, ACSLS and CDC milestone checklist. Behaviours such as babbling and imitating lip movements were removed from the final checklist, as they emerged after 6 months in the standardized checklists compared. Furthermore, these behaviours were reported by less number of professionals: babbling by 3 and imitating lip movements by 2 professionals out of a total of 8, further supporting their exclusion from the final checklist. While expert opinion regarding developmental milestones was the first level of input for the selection of behaviours for the study, verification with standardized checklists ensured that the milestones taken were in compliance with the checklists.

5.1.3 Finalization of Behaviours

The final behavioural checklist comprised 10 behaviours: 6 auditory and 4 speech behaviours, distributed across two age ranges: 0–2 months and 3–6 months.

The age range of 0–2 months included – responding to loud sounds and looking at the speaker while talking as auditory behaviours, and crying to express needs and vegetative sounds as speech behaviours. For the 3–6 months range, the auditory behaviours included – smiling in response to the caregiver's voice, quieting/calming on hearing a familiar voice, turning the head to lateral sides on hearing a familiar voice, and responding to musical tones. The speech behaviours for this age range include vocalizing back to the caregiver and cooing. The behaviour differential cry was removed from the final checklist, even though it was listed by the professionals, because it is difficult to video-record. The finalized behaviours were those rated by professionals as age-appropriate and were also easily recordable.

5.2 Video Recording of Behaviours

The second objective of the study was to record videos of the identified behaviours from the first stage. The recordings were taken from infants having confirmed normal hearing. Videos were recorded during the active periods of the infant, when the behaviour was more likely to occur naturally. Multiple takes for a single video was done to ensure co-operation from the child and the targeted behaviour was recorded accurately. Three videos representing each behaviour in the checklist were recorded. Three videos for each behaviour were recorded to account for natural variability in infant responses. This resulted in a total of 30 videos (3 per behaviour) recorded for 10 behaviours. These videos were collected, labeled and stored in the Google drive.

5.3 Validation of Recorded Videos

The third objective of the study was to validate the recorded videos by providing them to professionals and parents for identifying the video-recorded behaviours and matching them with age-appropriate groups.

5.3.1 Professional Validation of Recorded Videos

During the validation of the recorded videos, professionals were able to match the videos to the appropriate behaviours with 80% accuracy or more. Most of the videos had 100% matching accuracy except for two videos: one representing the behaviour 'Smiling in response to caregiver's voice' and the other representing the behaviour 'Cooing', both of which had a matching accuracy of 87.6%, with only two incorrect responses made by the same professional. The professional had assigned the behaviour "Smiling in response to caregiver's voice" to "Looking at the speaker while talking" and the behaviour "Cooing" as "Vocalizing back to the caregiver while talking". Since these behaviours are inherently subtle and closely resemble one another in their presentation, these videos could have been misinterpreted by professionals. Even among, experienced professionals 100% accuracy may not be expected as the age range boundaries of early auditory and speech milestones are not clearly defined and are highly overlapping. However, overall, professionals showed high accuracy in matching the videos with the targeted behaviours, indicating that all three were considered to truly represent the intended behaviours.

Professionals also demonstrated 100% accuracy in matching behaviours to the corresponding age ranges after viewing the videos. Since professionals showed high accuracy in matching the videos with both the targeted behaviours and age ranges, these videos can be considered as effective tools for parental counselling and student training.

To determine whether all three videos depicting each behaviour equally represent the intended behaviour, an equivalency rating was conducted with two professionals. All videos received a rating of 3 (moderately represented) or above on the 5-point Likert scale, indicating that all three videos for each behaviour were

adequate representations of the target behaviour. The finding confirms that multiple exemplars recorded for each behaviour are interchangeable in their representational quality. The high ratings obtained for the videos also suggest that these videos are adequately representing the target behaviour.

Overall, professionals demonstrated high accuracy in matching videos to behaviours and in identifying the age appropriateness of behaviours. This may be because professionals recruited for this phase of the study had a minimum of a master's degree in audiology or speech-language pathology and at least 8 years of experience working with the paediatric population. Academic and clinical training would have equipped them with a thorough understanding of early auditory and speech milestones, enabling them to observe, identify, and interpret these behaviours, even when some were subtle. Additionally, all professionals recruited for validation had young children of their own, which had further enhanced their knowledge of these behaviours through direct observation in their own children. Hence, trained audiologists and SLPs can suspect hearing loss in a child by observing auditory and speech milestones at an early age, enabling timely referral for detailed audiological evaluation.

5.3.2 Parental Validation of Recorded Videos

Validation results among parents showed lower accuracy in matching the videos with the intended behaviours than the professionals. Parents were able to perform better for behaviours in the age range of 0-2 months when compared to the behaviours in the age range of 3-6 months. In particular, several behaviours, such as cooing, vocalizing back to the caregiver, quieting/calming on hearing a familiar voice, and turning the head to lateral sides in the age range of 3-6 months, had notably low matching accuracies of 20%–40% across videos. Behaviours that can be easily

observed, such as response to loud sounds, crying to express needs, and vegetative sounds, showed a high matching accuracy of greater than 80%. Behaviours such as smiling in response to the caregiver's voice, looking at the speaker while talking, and responding to musical tones had accuracies ranging from 20% to 100%.

The poor matching accuracy of parents for behaviours in the age range of 3–6 months, particularly for speech behaviours such as cooing and vocalizing back to the caregiver, is clinically significant. This finding suggests that parents are less familiar with subtle communicative behaviours such as cooing, vocalizing, responding to familiar sounds, and head turn response to sounds seen in 3-6 months, compared to the more robust and reflexive behaviours seen in the 0–2 months range, such as crying to express needs, responding to loud sounds and vegetative sounds.

Parents also demonstrated lower accuracy in matching behaviours to age ranges than professionals. Parents showed lower matching accuracy for behaviours in the 3-6 months age range compared to 0-2 months. Most parents had matched those behaviours assigned to the 3-6 months age range by professionals to the 0-2 months age range. These findings highlight that most of the parents had underestimated the age range in which these behaviours occur.

Overall, the findings reveal that parents lack awareness of early auditory and linguistic milestones and that they are unable to identify and assign these behaviours in infants age-appropriately. This means to say that despite parents being 'new', they had not paid attention to these behaviours in their children. Parents being aware and observant of these behaviours were both lacking in the population studied. Although only 5 parents were recruited for validation, the findings are consistent with the existing literature, which consistently demonstrates poor parental awareness regarding early auditory and speech milestones (Lam et al., 2018; Aldayel et al., 2020;

Habbash et al., 2022; Kumar et al., 2024; Pallavi & Waknis, 2021; Varghese et al., 2020). Hence, parents recruited for the study, despite being a small sample, can be considered to represent the Indian parent population in terms of their awareness of early auditory and speech milestones.

In a country like India, where the NHS is implemented only in isolated pockets, parents' early suspicion of hearing loss is crucial. A qualitative study done in the state of Karnataka on parents of children with hearing loss found that there is a strong correlation between age of suspicion, age of diagnosis and age of intervention. Age of suspicion significantly predicts age of diagnosis and age of intervention. That is, early suspicion of hearing loss results in early identification and intervention (Pazhayapisharath & Maruthy, 2024). Parents' ability to detect developmental patterns will decide the age of intervention for the child.

Parents who are late to suspect their child's hearing loss are unable to detect hearing loss at an early age. In the study by Pazhayapisharath & Maruthy (2024), parents perceived a child's susceptibility to hearing loss based on two factors: a family history of hearing loss and delayed development. However, it is not necessary that every case of childhood hearing loss has a positive family history, and 70-80% of cases with non-syndromic congenital hearing loss follow a recessive pattern of inheritance (Sheffield & Smith, 2019). Hence, when there are no overt physical signs or a known possibility of hearing loss in the child, it becomes difficult for parents to suspect hearing loss in their child. The only tool in their possession shall be the ability to identify deviant behaviours.

In the absence of NHS, parents have to suspect hearing loss through deviant auditory behaviours or delayed speech and language development. However, it is also reported that deviant auditory behaviours are difficult to notice even by a trained

professional before 6 months of age (Thompson & Weber, 1974). Delay in speech and language development can be identified reliably only after 1 year of age, when there is a delay in the production of the first word (Rupert et al., 2023).For parents to suspect hearing loss in their children, they need to be aware of the early auditory behaviours and linguistic milestones. However, studies consistently show that there is a lack of awareness among parents of early developmental milestones.

For example, a study conducted in Hong Kong to assess parental knowledge and attitudes on the NHS and early hearing development found that around 80% of the parents thought that hearing loss would not develop after passing the NHS, and one-third of parents thought that hearing loss would not develop during infancy and childhood. They also found that only one-third of the participants were aware of the early auditory milestones and the age at which it is acquired. Even though most of the parents knew that hearing loss could affect speech and language development, the mean knowledge score for early auditory milestones was less than 50%. Among the auditory milestones assessed, 87.6% of the mothers identified when the child would quieten and listen to a familiar voice. However, only 17.5% of the parents knew the age at which the child responds to name-calling, and only 8.2% of the parents were aware of the age at which the child turns their head to voices (Lam et al., 2018).

Studies conducted across the countries report poor parental awareness of developmental milestones, especially in the speech and language domain. Research from South Asia and the Middle East reveals that a significant proportion of parents lack adequate knowledge of auditory and speech milestones, and only a small minority of the population demonstrates adequate knowledge of developmental milestones (Aldayel et al., 2020; Habbash et al., 2022; Kumar et al., 2024). These

findings indicate a globally prevalent gap in parental awareness of early auditory and speech milestones.

Another study done in Saudi Arabia assessed the knowledge level among parents on different developmental domains: motor, language, social and cognitive. They found that language and social domains had the lowest awareness level among parents (Alghamdi et al., 2023). Since auditory and speech behaviours are not overt or easily visible, it becomes difficult for parents to observe and monitor them in children.

In the Indian context, many studies also show a similar trend. Studies by Pallavi and Waknis (2021) and Varghese et al. (2020) have found that Indian parents have poor awareness of developmental milestones, showing more knowledge of gross motor domains than communication domains. Nagaria et al. (2024) have found that parents are more aware of broad milestones such as babbling and first word production, but are less aware of subtle early communicative milestones. A qualitative study conducted in Odisha found that pregnant women and new mothers rarely identify peri-natal risk factors, missed newborn hearing screening, and speech-language delays, necessitating anticipatory guidance (Sahoo et al., 2021)

Qualitative analysis of help-seeking behaviours among parents of children with hearing loss done in the state of Karnataka has found that the lack of awareness among parents on hearing loss and hearing rehabilitation was the most common identified barrier (Pazhayapisharath & Maruthy, 2024).

Based on national and international studies, it can be concluded that parents have limited awareness of developmental milestones, especially early auditory and speech milestones. Parents can identify overt, easily observable milestones, such as gross motor development, but demonstrate limited knowledge of subtle auditory and

speech milestones. Within auditory and speech milestones, parents are aware of later-developing milestones, such as first word production, but show limited awareness of early-developing auditory and speech milestones, such as responding to loud sounds, responding to musical tones and turning the head to familiar sounds. The findings of the present study are also consistent with this trend reported in the existing literature. Our study also found that parents lack awareness of early auditory and speech milestones, particularly subtle communicative behaviours. The majority were able to identify overt and reflexive behaviours that emerge during the 0-2 month's period. The finding also suggests that the child's communicative needs are not registered by the parents, which is the primary reason for missing developmental disorders. In particular, those communicative behaviours with an intention, such as cooing and vocalizing, are missed by parents.

Because parents are often unaware of early milestones, they typically suspect hearing loss only when a child shows a language delay. According to the study done by Pazhayapisharath & Maruthy (2024), parents begin to suspect hearing loss by 18 months, which is also the period when language delay becomes apparent in the child. The study also highlights that the median age difference between the age of suspicion, the age of identification, and the age of intervention is 3 months. Hence, when the average age of suspicion is delayed to 18 months, it further delays the age of identification and intervention.

Given the crucial role of early parental suspicion of hearing loss, it is important to provide counselling using standardized tools to effectively monitor these milestones. Standardized tools include checklists, questionnaires, applications and video-based tools. A systematic review and meta-analysis of 67 parental screening tools revealed that parent-reported screening tools have a sensitivity of

81% and are comparable to clinician-administered tools, and hence can be used for counselling. A review of 260 peer-reviewed studies conducted by Child Trends in the United States found that many first-time parents were interested in learning about developmental milestones but lacked access to appropriate information (Bartlett et al., 2018). Even though the CDC has published videos demonstrating typical developmental milestones for children aged 0-5 years, these videos are not standardised for the Indian population. Since India is a multicultural and multilingual country, the age at which milestones are attained may vary, as their development is influenced by cultural practices and linguistic background. Video modules can help parents to suspect hearing loss early and seek appropriate professional help, thereby promoting early identification and intervention. Hence, the current study aimed to develop video modules for the Indian population to support effective counselling of parents on early auditory and linguistic milestones, helping them become aware of typically developing milestones in growing children and monitor these milestones in their own children.

The video modules developed in the study can be used for the following purposes:

- Can be used as a counselling tool by audiologists and SLPs to improve parental awareness of early auditory and speech milestones, particularly during the NHS, when young parents can be counseled on typical milestones to expect in the coming months and to seek professional help if they deviate.
- Can be used as a proactive counselling tool for expectant mothers, helping them familiarize themselves with typical auditory and speech milestones even before birth. This anticipatory guidance would prepare parents to monitor these behaviours from the earliest stage of their child's life
- Can be used as a training tool for ASHA workers to identify and monitor these behaviours in children during well-child visits.

- Can be used for professional and student training to identify early auditory and speech behaviours, hence promoting timely referral for detailed audiological evaluations.

Chapter 6

SUMMARY AND CONCLUSION

Early identification and intervention of hearing loss is crucial to ensure optimal speech and language development in children. Even though JCIH (2019) recommends screening by 1 month, diagnosis by 3 months and intervention by 6 months, India lacks a structured NHS program, resulting in an average age of identification of 2-3 years (Ravi et al., 2017). This places enormous responsibility on parents to monitor their child's early auditory and speech milestones. However, research shows that most parents lack awareness of these early milestones. Even in countries where NHS is implemented, it fails to detect mild, progressive and late-onset hearing loss (Bess et al., 1998; Fowler et al., 1999), making ongoing developmental monitoring by parents necessary. Given that children identified before 6 months would have better outcomes, there is a need to ensure that parents are equipped with information to identify deviations in auditory and speech behaviours within 6 months of the infant's life. While tools like the CDC milestone tracker application are available to educate parents, these are developed in a Western context and are not culturally and linguistically adapted for the Indian population.

Hence, the current study aimed to develop and validate a culturally appropriate visual library of auditory and speech behaviours in infants aged 0-6 months. The developed tool enables parents to suspect hearing loss early, thereby promoting timely identification and intervention.

The study was conducted in three phases. In the first phase, a checklist was developed through the Delphi method, based on consensus from audiologists and speech-language pathologists, and cross-verified against existing standardized tools.

The final behavioural checklist comprised 10 behaviours: 6 auditory and 4 speech behaviours, distributed across two age ranges: 0–2 months and 3–6 months. The age range of 0–2 months included responding to loud sounds and looking at the speaker while talking as auditory behaviours, and crying to express needs and vegetative sounds as speech behaviours. For the 3–6 months range, the auditory behaviours included smiling in response to the caregiver's voice, quieting/calming on hearing a familiar voice, turning the head to lateral sides on hearing a familiar voice, and responding to musical tones. The speech behaviours for this age range include vocalizing back to the caregiver and cooing.

Videos were recorded from three different infants aged 0-6 months corresponding to each behaviour in the developed checklist. Videos were validated by parents and professionals by matching them to the appropriate behaviours and identifying the age range in which each behaviour occurs.

Professional validation results showed high matching accuracy for the videos with the targeted behaviours and in identifying the age ranges of the behaviours. The findings highlight that videos accurately represent the targeted behaviours and their assigned age ranges. Also, the professionals' equivalency rating showed that the three videos were equivalent in representing the targeted behaviour.

Parental matching accuracy and age-range identification, however, were poor. This was particularly so for subtle auditory and speech behaviours such as cooing, vocalising, responding to familiar voice and musical tones. These findings indicate a lack of awareness of early auditory and speech milestones. Our study findings were also consistent with the existing literature. These findings were especially concerning, as the parents selected for validation had children aged 6 months and still were unable to reliably identify and interpret these behaviours.

The lack of parental awareness regarding early auditory and speech developmental milestones underscores the need to develop standardized tools to enhance it. Since the recorded videos were validated by professionals, they can be considered as accurately representing the targeted auditory and speech behaviours. Hence, the developed visual library can be used effectively to counsel parents about early auditory and speech behaviours, enabling them to visually observe, identify, and interpret these behaviours in their own children. This, in turn, would help parents to identify any deviations from the normative, thereby facilitating early suspicion of hearing loss. Early suspicion would lead to early identification and intervention for hearing loss, ultimately improving outcomes for children with hearing loss.

Limitations of the Study

- The sample size for parental validation was small, and hence, the finding of a lack of awareness regarding auditory and speech milestones cannot be generalised to the entire Indian population, even though this finding is consistent with the existing literature.
- The socio-economic and educational status of the parents was not considered, which are well-documented factors that can affect parental awareness. Hence, the exclusion of these factors may have affected the results of parental validation of the videos.
- The participants in the video recording were from a single geographic location in Kerala, which may not reflect India's cultural and linguistic diversity, particularly since the intention of the study was cultural adaptation.

Future Directions of the Study

Future studies may be taken up to:

- Evaluate the effectiveness of the developed video library on new and expectant mothers for promoting parental awareness of early auditory and speech milestones. This can help establish its utility as a parental counselling and training resource.
- Extend video recording of auditory and speech behaviours to include children from 6 months to 5 years of age, as it is important to continuously monitor milestones even beyond 6 months.
- Record videos on a large sample of 0-6 months infants from different geographical location to ensure cultural representation of the Indian population.
- Integrate the recorded videos into a milestone-tracking application like CDC, which is culturally and linguistically adaptable for the Indian population. Such an application would serve as a free, accessible resource across the country for parents, caregivers and clinicians.
- Identify the pattern of parental awareness across different geographical locations in the country, using a larger sample, by assessing their ability to match videos to the targeted behaviours. Such findings would help identify regions with low parental awareness and report them to the government, so that targeted awareness programs and policy-level initiatives can be directed to these regions.
- Assess the level of awareness of early milestones among students in the field of Audiology and Speech Language Pathology, across different academic levels, from bachelor's to master's programs. This would help identify patterns of

awareness across grades and evaluate whether the current professional and clinical training is adequate to equip students to identify these milestones. In case of poor awareness noted during the assessment, training could also be given with the developed tool.

REFERENCES

Abercrombie, J., Wiggins, L., & Green, K. K. (2022). CDC's "Learn the Signs. Act Early." Developmental Milestone Resources to Improve Early Identification of Children with Developmental Delays, Disorders, and Disabilities. *Zero to Three*, *43*(1), 5–12.

Aldayel, A. S., Aldayel, A. A., Almutairi, A. M., Alhussain, H. A., Alwehaibi, S. A., & Almutairi, T. A. (2020). Parental Knowledge of Children's Developmental Milestones in Riyadh, Saudi Arabia. *International Journal of Pediatrics*, *2020*, 1–8. https://doi.org/10.115/2020/8889912

Alghamdi, H. M., Altirkistani, B. A., Baatya, R. A., Marghalani, Y. O., & Alshaikh, N. M. (2023). Bridging the Gap: Parents' Knowledge of Childhood Developmental Milestones and the Early Identification of Children With Developmental Delay. *Cureus*. https://doi.org/10.7759/cureus.48232

American Academy of Pediatrics. (2006). *Identifying infants and young children with developmental disorders in the medical home: An algorithm for developmental surveillance and screening*. *Pediatrics, 118*(1), 405–420. https://doi.org/10.1542/peds.2006-1231

American Speech-Language-Hearing Association. (2020). *Hearing loss in children*. https://www.asha.org/public/hearing/hearing-loss-in-children/

American Speech-Language-Hearing Association. (2023). *Hearing loss in children*. https://www.asha.org/practice-portal/clinical-topics/hearing-loss-in-children/

Bartlett, J. D., Guzman, L., & Ramos-Olazagasti, M. A. (2018, July 9). *Parenting Knowledge among First-time Parents of Young Children*.

https://www.childtrends.org/publications/parenting-knowledge-among-first-time-parents-of-young-children-a-research-to-practice-brief

Ben-Sasson, A., Jacobs, K., & Ben-Sasson, E. (2022). The feasibility of a crowd-based early developmental milestone tracking application. *PLOS ONE*, *17*(5), e0268548. https://doi.org/10.1371/journal.pone.0268548

Berlin, C. I., Hood, L. J., Morlet, T., Wilensky, D., Li, L., Mattingly, K. R., Taylor-Jeanfreau, J., Keats, B. J. B., John, P. St., Montgomery, E., Shallop, J. K., Russell, B. A., & Frisch, S. A. (2010). Multi-site diagnosis and management of 260 patients with Auditory Neuropathy/Dys-synchrony (Auditory Neuropathy Spectrum Disorder*). *International Journal of Audiology*, *49*(1), 30–43. https://doi.org/10.3109/14992020903160892

Bess, F. H., Dodd-Murphy, J., & Parker, R. A. (1998). Children with Minimal Sensorineural Hearing Loss: Prevalence, Educational Performance, and Functional Status: *Ear and Hearing*, *19*(5), 339–354. https://doi.org/10.1097/00003446-199810000-00001

Centers for Disease Control and Prevention. (2022). *Important milestones: Your baby by eighteen months*. U.S. Department of Health and Human Services. https://www.cdc.gov/ncbddd/actearly/milestones/milestones-18mo.html

Chandrashekhar, R., Dhaliwal, B. K., Rattani, A., Seth, R., Guruprasad, S., Khanna, H., & Shet, A. (2024). Adapting Child Development Assessment Tools to the Rural Indian Context. *Children*, *11*(9), 1115. https://doi.org/10.3390/children11091115

Ching, T. Y. C., & Leigh, G. (2020). Considering the impact of universal newborn hearing screening and early intervention on language outcomes for children

with congenital hearing loss. *Hearing Balance and Communication*, *18*(4), 215–224. https://doi.org/10.1080/21695717.2020.1846923

Choo, Y. Y., Agarwal, P., How, C. H., & Yeleswarapu, S. P. (2019). Developmental delay: Identification and management at primary care level. *Singapore Medical Journal*, *60*(3), 119–123. https://doi.org/10.11622/smedj.2019025

Constantinescu-Sharpe, G., Phillips, R. L., Davis, A., Dornan, D., & Hogan, A. (2017). Social inclusion for children with hearing loss in listening and spoken Language early intervention: An exploratory study. *BMC Pediatrics*, *17*(1), 74. https://doi.org/10.1186/s12887-017-0823-y

Dedhia, K., Kitsko, D., Sabo, D., & Chi, D. H. (2013). Children With Sensorineural Hearing Loss After Passing the Newborn Hearing Screen. *JAMA Otolaryngology–Head & Neck Surgery*, *139*(2), 119. https://doi.org/10.1001/jamaoto.2013.1229

Deng, X., Gaffney, M., & Grosse, S. D. (2020). Early Hearing Detection and Intervention in the United States: Achievements and Challenges in the 21st Century. *China CDC Weekly*, *2*(21), 378–382. https://doi.org/10.46234/ccdcw2020.097

Deshpande, S., & Bhogade, M. R. (2022). Identification and Intervention of Hearing Loss in Maharashtra: A Survey of Parental Experience. *Annals of Otology and Neurotology*, *5*(02), 062–068. https://doi.org/10.1055/s-0043-1764172

Donkor, F. (2011). *Assessment of learner acceptance and satisfaction with video-based instructional materials for teaching practical skills at a distance*. International Review of Research in Open and Distributed Learning, 12(5), 74–92. https://doi.org/10.19173/irrodl.v12i5.953

Ertem, I. O., Krishnamurthy, V., Mulaudzi, M. C., Sguassero, Y., Balta, H., Gulumser, O., Bilik, B., Srinivasan, R., Johnson, B., Gan, G., Calvocoressi, L., Shabanova, V., &

Forsyth, B. W. C. (2018). Similarities and differences in child development from birth to age 3 years by sex and across four countries: A cross-sectional, observational study. *The Lancet Global Health, 6*(3), e279–e291. https://doi.org/10.1016/S2214-109X(18)30003-2

Fowler, K. B., Dahle, A. J., Boppana, S. B., & Pass, R. F. (1999). Newborn hearing screening: Will children with hearing loss caused by congenital cytomegalovirus infection be missed? *The Journal of Pediatrics*, *135*(1), 60–64. https://doi.org/10.1016/S0022-3476(99)70328-8

Galhotra, A., & Sahu, P. (2019). Challenges and solutions in implementing hearing screening program in India. *Indian Journal of Community Medicine*, *44*(4), 299. https://doi.org/10.4103/ijcm.IJCM_73_19

Gandini, A., Salmah, U., Salmah, U., Arsin, A., Mallongi, A., & Mallongi, A. (2024). The Role of Parents in Monitoring the Growth and Development of Toddlers: A Systematic Review. *Pharmacognosy Journal*, *16*(3), 682–686. https://doi.org/10.5530/pj.2024.16.114

Glascoe, F. P. (1999). Using Parents' Concerns to Detect and Address Developmental and Behavioral Problems. *Journal for Specialists in Pediatric Nursing*, *4*(1), 24–35. https://doi.org/10.1111/j.1744-6155.1999.tb00077.x

Glascoe, F. P., & Marks, K. P. (2011). Detecting children with developmental-behavioral problems: The value of collaborating with parents. *Psychological Test and Assessment Modeling*, *53*(2), 258–279.

Gulati, S., Israni, A., Squires, J., Singh, A., Madaan, P., Kamila, G., & Pandey, R. M. (2023). Socio-cultural Adaptation and Validation of Ages and Stages Questionnaire (ASQ 3) in Indian Children Aged 2 to 24 Months. *Indian Pediatrics*, *60*(11), 908–912. https://doi.org/10.1007/s13312-023-3034-7

Habbash, A. S., Qatomah, A., Al-Doban, R., & Asiri, R. (2022). Parental knowledge of children's developmental milestones in Aseer, Saudi Arabia. *Journal of Family Medicine and Primary Care*, *11*(9), 5093–5102. https://doi.org/10.4103/jfmpc.jfmpc_2029_21

Harlor, A. D. B., Bower, C., Committee on Practice and Ambulatory Medicine, & the Section on Otolaryngology–Head and Neck Surgery. (2009). Hearing Assessment in Infants and Children: Recommendations Beyond Neonatal Screening. *Pediatrics*, *124*(4), 1252–1263. https://doi.org/10.1542/peds.2009-1997

Herawaty, T. (2021). *Effect of developmental stimulation videos for mothers on the level of development of infants aged 6–12 months as assessed by Griffith-III* (Master's thesis, Faculty of Medicine, Universitas Indonesia). Universitas Indonesia Library

Istiqomah, N., Sari, A. L., Yuliastuti, E., Asjad, S. U., & Rasyid, W. S. (2025). Utilization of Toddler Development Stimulation Videos in Improving Developmental Milestones: *Jurnal Berita Ilmu Keperawatan*, *18*(1), 105–113. https://doi.org/10.23917/bik.v18i1.7512

Joint Committee on Infant Hearing. (2007). Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. *Pediatrics, 120*(4), 898–921. https://doi.org/10.1542/peds.2007-2333

Joint Committee on Infant Hearing. (2019). *Year 2019 position statement: Principles and guidelines for early hearing detection and intervention programs*. *Journal of Early Hearing Detection and Intervention, 4*(2), 1–44. https://doi.org/10.15142/fptk-b748

Joint Committee on Infant Hearing. (2019). *Year 2019 position statement: Principles and guidelines for early hearing detection and intervention programs*. Journal of Early Hearing Detection and Intervention, 4(2), 1–44.

Karama, R. S., Simon, N. H., Chatterjee, A., Aswasthi, S., Akinola, A., Acharya, S., Praveen, U., Lachyan, A., Khan, S., & Gangurde, P. (2022). Effectiveness of video-based teaching program to assess the knowledge of young mothers in identifying developmental milestones in Delhi NCR, India. *International Journal of Health Sciences*, 12194–12204. https://doi.org/10.53730/ijhs.v6nS1.8281

Kelly, Y., Sacker, A., Schoon, I., & Nazroo, J. (2006). Ethnic differences in achievement of developmental milestones by 9 months of age: The Millennium Cohort Study. *Developmental Medicine & Child Neurology*, *48*(10), 825. https://doi.org/10.1017/S0012162206001770

Kemp, D. T. (2002). Otoacoustic emissions, their origin in cochlear function, and use. *British Medical Bulletin*, *63*(1), 223–241. https://doi.org/10.1093/bmb/63.1.223

Kennedy, C., McCann, D., Campbell, M., Law, C., Mullee, M., Petrou, S., Watkin, P., Worsfold, S., Yuen, H., & Stevenson, J. (2007). Language ability after early detection of permanent childhood hearing impairment. *Community Ear and Hearing Health*, *4*(5), 9. https://doi.org/10.56920/cehh.177

Knoetze, M., Manchaiah, V., Mothemela, B., & Swanepoel, D. W. (2023). Factors Influencing Hearing Help-Seeking and Hearing Aid Uptake in Adults: A Systematic Review of the Past Decade. *Trends in Hearing*, *27*, 23312165231157255. https://doi.org/10.1177/23312165231157255

Kral, A., & Sharma, A. (2012). Developmental neuroplasticity after cochlear implantation. *Trends in Neurosciences*, *35*(2), 111–122. https://doi.org/10.1016/j.tins.2011.09.004

Kumar, R., Ali, M., Pasha, M. S., Ansari, H. W., & Durrani, N. (2024). Knowledge, attitude, and practices of parents regarding the red flags of developmental milestones in children aged 0–5 years in Karachi, Pakistan: A cross-sectional study. *BMC Pediatrics*, *24*(1), 120. https://doi.org/10.1186/s12887-024-04574-9

Kumar, S., & Mohapatra, B. (2011). Status of newborn hearing screening program in India. *International Journal of Pediatric Otorhinolaryngology*, *75*(1), 20–26. https://doi.org/10.1016/j.ijporl.2010.09.025

Lam, M. Y. Y., Wong, E. C. M., Law, C. W., Lee, H. H. L., & McPherson, B. (2018). Maternal knowledge and attitudes to universal newborn hearing screening: Reviewing an established program. *International Journal of Pediatric Otorhinolaryngology*, *105*, 146–153. https://doi.org/10.1016/j.ijporl.2017.12.021

Lee, J. H., Lee, N. H., Yoon, I. J., Hong, M. J., Choi, E. J., Jang, B. H., Chang, J. Y., Lee, B. S., Jung, E., Sung, I. Y., & Ko, E. J. (2024). The Effect of Group-Based Early Parent Education on Development in Preterm Infants. *Children*, *11*(12), 1461. https://doi.org/10.3390/children11121461

Liang, W. H. K., Gn, L. W. E., Tan, Y. C. D., & Tan, G. H. (2023). Speech and language delay in children: A practical framework for primary care physicians. *Singapore Medical Journal*, *64*(12), 745–750. https://doi.org/10.4103/singaporemedj.SMJ-2022-051

Lipkin, P. H., & Macias, M. M. (2020). *Promoting optimal development: Identifying infants and young children with developmental disorders through developmental surveillance and screening*. *Pediatrics, 145*(1), e20193449. https://doi.org/10.1542/peds.2019-3449

Lutman, M. E., Davis, A. C., Fortnum, H. M., & Wood, S. (1997). Field Sensitivity of Targeted Neonatal Hearing Screening by Transient-Evoked Otoacoustic Emissions: *Ear and Hearing*, *18*(4), 265–276. https://doi.org/10.1097/00003446-199708000-00001

Manchaiah, V., Sivaprasad, M., Chundu, S., & Dutt, S. (2010). Ear and Hearing Healthcare Services in India. ENT & Audiology News, 19, 93 95.https://doi.org/10.1097/AUD.0b013e3181cbc79a

McLaughlin, M. R. (2011). Speech and language delay in children. *American Family Physician*, *83*(10), 1183–1188.

Mehl, A. L., & Thomson, V. (1998). Newborn Hearing Screening: The Great Omission. *Pediatrics*, *101*(1), e4–e4. https://doi.org/10.1542/peds.101.1.e4

Merugumala, S. V., Pothula, V., & Cooper, M. (2017). Barriers to timely diagnosis and treatment for children with hearing impairment in a southern Indian city: A qualitative study of parents and clinic staff. *International Journal of Audiology*, *56*(10), 733–739. https://doi.org/10.1080/14992027.2017.1340678

Moeller, M. P. (2000). Early Intervention and Language Development in Children Who Are Deaf and Hard of Hearing. *Pediatrics*, *106*(3), e43–e43. https://doi.org/10.1542/peds.106.3.e43

Moeller, M. P., & Tomblin, J. B. (2015). An Introduction to the Outcomes of Children with Hearing Loss Study. *Ear & Hearing*, *36*(Supplement 1), 4S-13S. https://doi.org/10.1097/AUD.0000000000000210

Morgado, M., Botelho, J., Machado, V., Mendes, J. J., Adesope, O., & Proença, L. (2024). Video-based approaches in health education: A systematic review and meta-analysis. *Scientific Reports*, *14*(1), 23651. https://doi.org/10.1038/s41598-024-73671-7

Mulrine, C., & Kollia, B. (2015). Speech, language, hearing delays: Time for early intervention? *The Journal of Family Practice*, *64*(3), E1-9.

Nagaria, T. D., Shukla, S., Acharya, S., Acharya, N., & Shinde, R. K. (2024). Mothers making milestones: Awareness of rural mothers toward pediatric milestones. *Journal of Family Medicine and Primary Care*, *13*(10), 4444–4450. https://doi.org/10.4103/jfmpc.jfmpc_1419_23

Nair, M. K. C., Harikumaran Nair, G. S., Mini, A. O., Indulekha, S., Letha, S., & Russell, P. S. (2013). Development and validation of Language Evaluation Scale Trivandrum for children aged 0–3 years—LEST (0–3). *Indian Pediatrics*, *50*(5), 463–467. https://doi.org/10.1007/s13312-013-0154-5

National Institute on Deafness and Other Communication Disorders. (2022). *Speech and language developmental milestones*. National Institutes of Health. https://www.nidcd.nih.gov/health/speech-and-language

Neumann, K., Euler, H. A., Chadha, S., & White, K. R. (2020). *A Survey on the Global Status of Newborn and Infant Hearing Screening*.

Núñez Batalla, F. J., Fernández-Cedrón Bermejo, C., Guntín García, M., Sandoval Menéndez, I., Fresno Díaz, E., Gómez Martínez, J. R., & Llorente Pendás, J. L. (2023). Universal neonatal hearing screening and delayed hearing loss or late-developmental hearing loss. *Acta Otorrinolaringologica (English Edition)*, *74*(5), 283–289. https://doi.org/10.1016/j.otoeng.2022.10.007

Olusanya, B. O., Neumann, K. J., & Saunders, J. E. (2014). The global burden of disabling hearing impairment: A call to action. *Bulletin of the World Health Organization*, *92*(5), 367–373. https://doi.org/10.2471/BLT.13.128728

Otorhinolaryngology Age of identification of hearing impairment in Mumbai — A

Pallavi, P., & Waknis, A. P. (2021). Awareness of typical speech-language development among parents of children with hearing impairment. *International Journal of Otorhinolaryngology and Head and Neck Surgery*, *7*(7), 1136–1143. https://doi.org/10.18203/issn.2454-5929.ijohns20212449

Pan, K., Shang, Z., Liu, J., Wen, Y., Luo, J., Zou, D., Wang, A., Li, T., Liao, L., & Xie, P. (2024). Newborn concurrent hearing and genetic screening for hearing impairment: A systematic review and meta-analysis. *Experimental and Therapeutic Medicine*, *28*(3), 1–9. https://doi.org/10.3892/etm.2024.12654

Pazhayapisharath, I. C., & Maruthy, S. (2024). Help-seeking behaviour of parents of children with hearing loss in India: A qualitative analysis. *International Journal of Audiology*, *63*(9), 722–730. https://doi.org/10.1080/14992027.2023.2272557

Pazhayapisharath, I. C., & Maruthy, S. (2024). Situational assessment of age of suspicion, diagnosis, and intervention of hearing loss in pediatric population in India and factors that influence them. *Clinical Epidemiology and Global Health*, *30*. https://doi.org/10.1016/j.cegh.2024.101801

Prakash, P., Lakshmi, S., Sreedhar, A., Mathur, A. V., & Konadath, S. (2023). Validation of LittleEARS questionnaire in Hindi language. *Journal of Otology*, *18*(2), 71–78. https://doi.org/10.1016/j.joto.2022.12.003

Prieve, B. A., & Stevens, F. (2000). The New York State Universal Newborn Hearing Screening Demonstration Project: Introduction and Overview: *Ear and*

Hearing, *21*(2), 85–91. https://doi.org/10.1097/00003446-200004000-00003

Ramkumar, V. (2017). *A REVIEW OF NEONATAL HEARING SCREENING PRACTICES IN INDIA*. https://doi.org/10.17430/902592

Rasheed, N., Solanki, B., Awasthi, S., Kaushik, M., Lachyan, A., Ahmad, M., & Shaban, M. (2022). Efficacy of virtual education program to evaluate the knowledge of young mothers in Developmental Milestones: A survey in Delhi/NCR. *International Journal of Health Sciences*, *6*(S1), 6319–6325. https://doi.org/10.53730/ijhs.v6nS1.6347

Ravi, R., Gunjawate, D. R., Yerraguntla, K., Lewis, L. E., & Rajashekhar, B. (2017). A national survey of knowledge, attitude and practices among pediatricians towards newborn hearing screening in India. *International Journal of Pediatric Otorhinolaryngology*, *95*, 9–14. https://doi.org/10.1016/j.ijporl.2017.01.032

Ravi, R., Yerraguntla, K., Gunjawate, D. R., Rajashekhar, B., Lewis, L. E., & Guddattu, V. (2016). Knowledge and attitude (KA) survey regarding infant hearing loss in Karnataka, India. *International Journal of Pediatric Otorhinolaryngology*, *85*, 1–4. https://doi.org/10.1016/j.ijporl.2016.03.012

RBSK. Operational guidelines, MOHFW, Government of India. (2013)

Rikhy, S., Tough, S., Trute, B., Benzies, K., Kehler, H., & Johnston, D. W. (2010). Gauging knowledge of developmental milestones among Albertan adults: A cross-sectional survey. *BMC Public Health*, *10*(1), 183. https://doi.org/10.1186/1471-2458-10-183

Rout, N., & Singh, U. (2010). Age of suspicion, identification and intervention for rural indian children with hearing loss. Eastern Journal of Medicine, 15(3), 97–102.

Ruben, R. J. (1991). Effectiveness and Efficacy of Early Detection of Hearing Impairment in Children. *Acta Oto-Laryngologica*, *111*(sup482), 127–135. https://doi.org/10.3109/00016489109128036

Rupert, J., Hughes, P., & Schoenherr, D. (2023). Speech and Language Delay in Children. *American Family Physician*, *108*(2), 181–188.

Sahoo, S., Rautara, S., Dash, N., Panigrahi, S., K, B., & pal. (2021). A Qualitative Study on Awareness of Hearing Health, Hearing Impairment and Intervention Among Pregnant Women and Mothers of Newborn in Rural Khordha District. *Annals of Medical and Health Sciences Research*, *11*(11). https://www.amhsr.org//abstract/a-qualitative-study-on-awareness-of-hearing-health-hearing-impairment-and-intervention-among-pregnant-women-and-mothers--8804.html

Sheffield, A. M., & Smith, R. J. H. (2019). The Epidemiology of Deafness. *Cold Spring Harbor Perspectives in Medicine*, *9*(9), a033258. https://doi.org/10.1101/cshperspect.a033258

Shonkoff, J. P., & Meisels, S. J. (Eds.). (2000). *Handbook of early childhood intervention* (2nd ed.). Cambridge University Press.

Sices, L. (2007, December 1). *Developmental Screening in Primary Care: The Effectiveness of Current Practice and Recommendations for Improvement*. https://www.commonwealthfund.org/publications/fund-reports/2007/dec/developmental-screening-primary-care-effectiveness-current

Silveira, R. C., Valentini, N. C., O'Shea, T. M., Mendes, E. W., Froes, G., Cauduro, L., Panceri, C., Fuentefria, R. N., & Procianoy, R. S. (2024). Parent-Guided Developmental Intervention for Infants With Very Low Birth Weight: A

Randomized Clinical Trial. *JAMA Network Open*, *7*(7), e2421896. https://doi.org/10.1001/jamanetworkopen.2024.21896

Smith, J. D., Dishion, T. J., Moore, K. J., Shaw, D. S., & Wilson, M. N. (2013). Effects of Video Feedback on Early Coercive Parent–Child Interactions: The Intervening Role of Caregivers' Relational Schemas. *Journal of Clinical Child & Adolescent Psychology*, *42*(3), 405–417. https://doi.org/10.1080/15374416.2013.777917

So, K. K. H., & To, C. K. S. (2022). Systematic Review and Meta-Analysis of Screening Tools for Language Disorder. *Frontiers in Pediatrics*, *10*. https://doi.org/10.3389/fped.2022.801220

Subodh, G., & Rangasayee, R. (2011). International Journal of Pediatric Otorhinolaryngology Age of identification of hearing impairment in Mumbai — A trend analysis. *International Journal of Pediatric Otorhinolaryngology*, *75*(12), 1549–1552. https://doi.org/10.1016/j.ijporl.2011.09.005

Thompson, G., & Weber, B. A. (1974). Responses of Infants and Young Children to Behavior Observation Audiometry (BOA). *Journal of Speech and Hearing Disorders*, *39*(2), 140–147. https://doi.org/10.1044/jshd.3902.140

Tierney, A. L., & Nelson, C. A. (2009). Brain Development and the Role of Experience in the Early Years. *Zero to Three*, *30*(2), 9–13.

trend analysis. International Journal of Pediatric Otorhinolaryngology, 75(12),

Varghese, S. S., Joseph, M., Gohil, R., Thomas, S., Jose, S. M., Lukose, P., & Johnson, A. R. (2020). How aware are mothers about early childhood developmental milestones? A cross-sectional study at a maternity hospital in rural South India. *Indian Journal of Child Health*, *7*(11), 441–445.

Verma, R. R., Konkimalla, A., Thakar, A., Sikka, K., Singh, A. C., & Khanna, T. (2022). Prevalence of hearing loss in India. *The National Medical Journal of India*, *34*, 216–222. https://doi.org/10.25259/NMJI_66_21

Wetherby, A. M., & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile,, 1st normed ed* (pp. x, 177). Paul H Brookes Publishing Co.

White, K. R., Forsman, I., Eichwald, J., & Munoz, K. (2010). The Evolution of Early Hearing Detection and Intervention Programs in the United States. *Seminars in Perinatology*, *34*(2), 170–179. https://doi.org/10.1053/j.semperi.2009.12.009

World Health Organization. (2021). *World report on hearing*. World Health Organization. https://www.who.int/publications/i/item/9789240020481

Wood, S. A., Sutton, G. J., & Davis, A. C. (2015). Performance and characteristics of the Newborn Hearing Screening Programme in England: The first seven years. *International Journal of Audiology*, *54*(6), 353–358. https://doi.org/10.3109/14992027.2014.989548

World Health Organization. (2017). *Global costs of unaddressed hearing loss and cost-effectiveness of interventions*

Xiao, X., Wong, R. M., & Yang, W. (2024). Effectiveness of video-based health promotion: A systematic review and meta-analysis. *Patient Education and Counseling*, *119*, 108095. https://doi.org/10.1016/j.pec.2023.108095

Yoshinaga-Itano, C. (2003). Early intervention after universal neonatal hearing screening: Impact on outcomes. *Mental Retardation and Developmental Disabilities Research Reviews*, *9*(4), 252–266. https://doi.org/10.1002/mrdd.10088

Yoshinaga-Itano, C. (2014). Principles and Guidelines for Early Intervention After Confirmation That a Child Is Deaf or Hard of Hearing. *Journal of Deaf Studies and Deaf Education*, *19*(2), 143–175. https://doi.org/10.1093/deafed/ent043

Yoshinaga-Itano, C., Sedey, A. L., Coulter, D. K., & Mehl, A. L. (1998). Language of Early- and Later-identified Children With Hearing Loss. *Pediatrics*, *102*(5), 1161–1171. https://doi.org/10.1542/peds.102.5.1161

Yoshinaga-Itano, C., Sedey, A. L., Wiggin, M., & Chung, W. (2017). Early Hearing Detection and Vocabulary of Children With Hearing Loss. *Pediatrics*, *140*(2), e20162964. https://doi.org/10.1542/peds.2016-2964

Zaidman-Zait, A., & Most, T. (2005). Cochlear Implants in Children with Hearing Loss: Maternal Expectations and Impact on the Family. *Volta Review*, *105*(2), 129–150.

Zubler, J. M., Wiggins, L. D., Macias, M. M., Whitaker, T. M., Shaw, J. S., Squires, J. K., Pajek, J. A., Wolf, R. B., Slaughter, K. S., Broughton, A. S., Gerndt, K. L., Mlodoch, B. J., & Lipkin, P. H. (2022). Evidence-Informed Milestones for Developmental Surveillance Tools. *Pediatrics*, e2021052138. https://doi.org/10.1542/peds.2021-052138

APPENDIX 1

All India Institute of Speech and Hearing
(An autonomous Institute under the
Ministry of Health and Family Welfare, Govt. of India)
Center of Excellence - Assessed & Accredited by NAAC with 'A' Grade
ISO 9001:2015 Implemented Institute
Manasagangothri, Mysuru-570006

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INSTITUTE REVIEW BOARD (IRB) APPROVAL FOR BIO-BEHAVIOURAL RESEARCH PROPOSAL INVOLVING HUMAN SUBJECTS AT AIISH

AIISH Institute Review Board (IRB)

Ref: SH/IRB/M.4/AUD.38/2025-26 **Date:06.01.2026**

Title of the Dissertation	: Development and validation of a visual library of auditory and speech behaviours in infants
Name of the Investigator	: Vaishnavi S Raj
Guide	: Dr. Indira C P
Co-Guide (if any)	: Nil
Proposed Duration of the Project	: 08 months
Source of funding	: Non-funded Master's dissertation
Estimated budget	: Nil
Reference Number of the Project	: Nil
Date on which the IRB meeting was held	: 02.01.2026
A clear statement of the decision reached IRB meeting (In the vent of the proposal is not approved, a statement of reasons for the same must be indicated)	: **APPROVED**
Advice & suggestions (if any)	: NIL

Signature & Name of the Member Secretary-IRB
Dr. Animesh Barman
Professor of Audiology
All India Institute of Speech and Hearing, Mysore-570006

सदस्य सचिव / Member Secretary
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APPENDIX 2

Scripts for Video Recording of the Behaviours

Age Range: 0-2 months

Auditory Behaviours

Script 1: Responding to loud sounds

- Infant position: Lying in supine position (on the back) on the baby bed on the floor
- Camera position: The camera is to be positioned directly above the infant to clearly capture facial expressions and body reactions
- Stimulus: Hand-held drum to be at 3 feet, 6 feet and 9 feet behind the infant. The drum sound should come from behind the infant, outside the infant's visual field. Visual cues will not be provided. A microphone was placed near the drum to clearly capture the drum sound
- Infant state: In a calm and quiet state
- Expected Response: Startle response/ eye blinking/ eye widening/ change in facial expressions/ crying

Script 2: Looking at the speaker while talking

- Infant position: The child is to be placed on the bed facing the caregiver
- Camera position: Place the camera on the lateral side (to the caregiver's side) to capture both the caregiver and the infant. The camera will focus on the child's face, with the caregiver also being visible in the video.

- Stimulus: The caregiver will start speaking to the infant in motherese, making eye contact with the child. The microphone will be clipped to the caregiver's dress to capture the caregiver's speech.
- Infant state: Calm and attentive state
- Expected response: Infant will look at the caregiver while speaking

Speech Behaviours

Script 3: Crying to express needs

- Infant position: Lying in supine position (on the back) on the baby bed
- Camera position: Place the camera on the lateral side of the infant
- Stimulus: No stimulus is given
- Infant state: Hunger/discomfort. The microphone will be clipped to the infant's dress to capture the infant's sound
- Expected response: Infant will start crying to express the need and stop crying once the need is met

Script 4: Sucking

- Infant position: Lying in supine position (on the back) on the baby bed/ On the mother's lap (if the child is being fed with a bottle)
- Camera position: Place the camera at the lateral side of the infant's face (approximately at mouth level), allowing a clear view of the jaw movements, lip seal, and tongue activity during sucking.
- Stimulus: A pacifier is provided, and the caregiver will guide the pacifier towards the infant's mouth. If the child is fed with a bottle, a bottle of milk will be provided. A microphone is clipped to the child's dress to capture the sound.
- Infant state: Hunger

- Expected response: First, the infant will be recorded in a calm state. Then the caregiver will place the pacifier/bottle in the baby's mouth, and the sucking movements, including jaw, lip movements, and facial expression, will be captured

Age Range: 3-6 Months

Auditory Behaviours

Script 5: Turning the head to a familiar voice presented at the lateral sides

- Infant position: Child will be placed in a s supine position on the baby bed on the floor.
- Camera position: Placed in front of the infant. The caregiver giving stimuli will also be recorded.
- Stimulus: The caregiver will call the child's name from the lateral side. The microphone is clipped to the caregiver's clothing who is presenting the stimulus
- Infant state: Calm and quiet with eyes open
- Expected response: Head turn towards the side of sound/eye gaze towards the side of voice.

Script 6: Calming on hearing a familiar voice / Quieting on hearing a familiar voice

- Infant position: Lying in supine position (on the back) on the baby bed
- Camera position: Place the camera overhead to capture the infant's reactions
- Stimulus: Caregiver's voice (either calling the child's name or speaking in motherese), which is presented out of the visual field of the infant. A

microphone will be clipped to the caregiver's clothes as well as to the infant's clothes to record the sounds

- Infant state: Child will be crying/ in a fussy state.
- Expected response: The infant will stop crying / calms on hearing the caregiver's voice

Script 7: Smiling in response to the caregiver's voice

- Infant position: Child will be placed on the bed lying in the supine position.
- Camera position: Camera placed on the lateral side to capture both caregiver and infant. Focus will be on the infant to capture the smiling response.
- Stimulus: The caregiver will start speaking to the infant in motherese, making eye contact with the child
- Infant state: Child should be quiet, calm and attentive
- Expected response: Infant will look at the caregiver while speaking and smile in response to the caregiver's voice

Script 8: Showing interest in musical tones/Responding to musical tones

- Infant position: Child will be placed on the bed lying in the supine position.
- Camera position: Camera placed overhead to capture the child's reactions
- Stimulus: Music or a rhyme that the child likes will be played. A microphone is placed near the source of the music, and a second microphone is clipped to the infant's clothing to capture vocalizations.
- Infant state: Child should be quiet, calm and attentive
- Expected response: Responds to musical tones presented either by head turn/smiling/vocalisations/cessation of activity/searching for the sound.

Speech Behaviours

Script 9: Cooing

- Infant position: Child will be placed in supine position on the baby bed
- Camera position: Camera placed overhead to capture the infant's vocalization. The microphone will be clipped to the infant's clothing
- Stimulus: No stimulus is given. The caregiver will be asked when the behaviour will usually occur, and the recording will be taken accordingly
- Infant state: The Child should be quiet and calm
- Expected response: Cooing

Script 10: Vocalizing back to the caregiver

- Infant position: Infant will be placed on the bed in the supine position, facing the caregiver
- Camera position: Camera placed on the lateral side to capture both caregiver and infant. More focus will be on the child's face to capture the child's response.
- Stimulus: The caregiver will begin speaking to the infant in motherese, making eye contact with the infant. The microphone will be clipped to both the infant's and the caregiver's clothing.
- Infant state: Child should be quiet, calm and attentive
- Expected response: Infant will look at the caregiver while speaking and vocalize in response to the caregiver's voice.