EFFECT OF NOVEL APPROACH AUTISM-CENTERED THERAPY FOR CHILDHOOD APRAXIA OF SPEECH (ACT4CAS) ON SPEECH AND LANGUAGE SKILLS IN MINIMALLY VERBAL CHILDREN WITH AUTISM SPECTRUM DISORDER

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CERTIFICATE

This is to certify that this dissertation entitled **“Effect of novel approach Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) on speech and language Skills in minimally verbal children with Autism Spectrum Disorder”** is a bonafide work submitted in part of fulfillment for the degree of Master of Science (Speech-Language Pathology) of the student with Registration number: P01II22S123036. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
July 2024

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DECLARATION

This is to certify that this dissertation entitled **“Effect of novel approach Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) on Speech and Language Skills in minimally verbal children with Autism Spectrum Disorder”** is the result of my own study under the guidance of Dr. Amulya P Rao, Assistant Professor in Language Pathology, 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 **Registration number: P01II22S123036**

July, 2023

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CHAPTER I

Introduction

“Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and the presence of restricted interests and repetitive behaviours” (*DSM*, n.d.). “It is estimated that the number of children with this condition in the world is 62 out of 10,000” (Elsabbagh et al., 2012). The prevalence ratio of ASD in the United States has increased two-folds, rising from 1 in 150 individuals between 2000 and 2002 to 1 in 68 individuals between 2010 and 2012 (Baio et al., 2018). In Asia, the prevalence rate is 0.4% (Salari et al., 2022). In India, the prevalence of ASD is reported to be 0.15%, based on the diagnosis of ASD in 43 children out of a total population of 28,070 children aged 1–10 years across diverse settings, including rural, urban, and tribal areas (Raina et al., 2017).

ASD manifests with a diverse spectrum of challenges during speech and language development. These disruptions in speech and language development can have broad and negative consequences, affecting not only communication but also the acquisition of new knowledge and full participation in society. Hence, speech and language problems have been a major concern for the caretakers’ of children with ASD (Anderson et al., 2007).

Children with ASD may exhibit a spectrum of communication abilities, ranging from being verbal to non-verbal, encompassing varying levels of speech and language skills (Anderson et al., 2007). Estimates of the proportion of children with ASD who are minimally verbal vary from 25% to 35% (Rose et al., 2016). Hence, a sub group of children with ASD fail to acquire speech and language skills beyond minimal level, with major restrictions in verbal expression, despite access to intervention from an early age. This may be due to the presence of apraxia or oral-motor impairment along with ASD impacting their ability to communicate. However, it is the “absence of communicative intent” due to social deficits that often disguises itself as an expressive language impairment (Mody & Belliveau, 2012).

‘Minimally verbal’ individuals with ASD typically have minimal or no functional speech, often using fewer than 20 words or phrases spontaneously and inconsistently (Tager-Flusberg & Kasari, 2013). What causes only a few children to be minimally verbal is not yet known primarily because of the diversity within ASD population and because of lack of comprehensive and standardized evaluation strategies for this population. Minimally verbal children with ASD have been reported to exhibit a restricted consonant inventory and phonetic repertoire (Saul & Norbury, 2020). Research has revealed that motor speech impairment (Chenausky et al., 2019) predict the level of expressive language skills indicating possibility of co-occurrence of Childhood Apraxia of Speech (CAS) alongside ASD. Children with co-occurring ASD and CAS remain non-verbal for a longer period of time due to major difficulty in acquiring language. Once verbal, they present with high speech sound errors.

Research related to treatment strategies and treatment efficacy in this population have also been very limited. Recently developed motor-based speech/language interventions such as PROMPT (Prompts for Restructuring Oral Muscular Phonetic Targets), AMMT (Auditory– Motor mapping training), tDCS/TMS (Transcranial direct current stimulation/ Transcranial magnetic stimulation) are seen to produce promising results (Chenausky et al., 2016; Prillinger et al., 2021; McCleery et al., 2013). PROMPT a neuro-developmental approach for speech production disorders, has been found to be effective in intervention for non-verbal children with ASD only when combined with other behaviour-oriented models such as Denver Model (Rogers et al., 2006). AMMT capitalizes on the inherent musical strengths of children with autism. It is a structured approach that focuses solely on the speech production aspects utilizing the visual and auditory cues (Wan et al., 2011). It does not tap on speech motor-related deficiencies present in children with ASD. In addition, PROMPT and AMMT strategies also fail to tap on the social-communication difficulties faced by children with ASD.

Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) is a therapeutic intervention developed for treating speech sound disorder in children who have both ASD and CAS. It is a theoretically motivated and clinically grounded treatment approach. It employs multiple techniques that are empirically supported and are designed to utilize the strengths of children with ASD (Beiting & Maas, 2021). It encorporates principles of motor learning (PML; Maas et al., 2008) and selects treatment targets based on the child's phonetic repertoire and phonotactic abilities to treat the CAS component. And it incorporates strategies such as pre-recorded video models, visual schedules and play-based activities to increase the motivation and reduce problematic behaviors in children with ASD (Dunlap & Koegel, 1980).

Need for the study

Approaches like PROMPT and AMMT have demonstrated positive outcomes in addressing motor-speech difficulties. Nevertheless, these approaches, like many others designed for motor-speech difficulties, primarily involve the repetitive practice of a single target. The repetitive practice of challenging tasks may induce problematic behaviors in children with ASD (Koegel et al., 1992). Hence, therapeutic approaches such as ACT4CAS, which address speech-motor difficulties while considering the social-communication challenges in children with ASD, encompassing elements like maintaining joint attention and interpreting live models through eye-gaze, might hold promise for yielding positive outcomes.

ACT4CAS is a novel approach. Studies on its efficacy in treating speech sound problems in children with both ASD and CAS is only in preliminary stages. There has been only one study by Beiting and Maas (2021), who are also the proposers of this novel approach. In this single-case experimental study, ACT4CAS has been tested as a speech treatment option for three minimally verbal children with both ASD and CAS. The speech production aspects are treated by emphasizing on principles of motor learning through drill based practice and incorporating prompt hierarchy. The primary measures taken in this study are accuracy and variability of target utterances across the treatment sessions.

However, effect of ACT4CAS on consonant and vowel inventories in individuals with ASD has not been investigated. The effectiveness of the therapy with regards to communicating skills has not also been studied. This is significant because speech production and a rich consonant inventory have been found to be major indicators of language development in children with ASD (Saul & Norbury, 2020).

Imitation skills are essential for the speech and language acquisition in developmental milestones. And children with ASD often have difficulties with imitation (Bloom et al., 1974; Bravo & Schwartz, 2021). Also, imitation can be particularly challenging for minimally verbal children with ASD, who may have speech motor production deficits. Hence, improvement in ability to imitate speech sounds or become stimulable for speech sound production could be a significant step forward (Bravo & Schwartz, 2021).

Given the correlation between improved speech production skills and better language abilities (Saul & Norbury, 2020), it is essential to investigate how ACT4CAS influences social communication and language skills in minimally verbal children with ASD. Hence, the current case study aims to explore these aspects, providing valuable insights into the potential benefits of ACT4CAS.

Aim

To find the effect of Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) on speech and language skills in minimally verbal children with ASD.

Objectives

To find if ACT4CAS intervention leads to improvement in the following language parameters:

1. Verbal expressive repertoire.
2. Social communication and language measures.

To find if ACT4CAS intervention leads to improvement in the following speech parameters:

1. Consonant inventory.
2. Vowel inventory.
3. Stimulability to speech sound production.

Hypothesis

1. ACT4CAS therapy approach has no impact on verbal expressive repertoire.
2. ACT4CAS therapy approach has no impact on social communication and language measures.
3. ACT4CAS therapy approach has no impact on consonant inventory.

4. ACT4CAS therapy approach has no impact on vowel inventory.
5. ACT4CAS therapy approach has no impact on stimulability to speech sounds.

CHAPTER II

REVIEW OF LITERATURE

Autism Spectrum Disorder (ASD)

ASD is a neurological and developmental disorder that affects how people interact with others, communicate, learn, and behave (*Autism Spectrum Disorder*, n.d.). It is historically characterized by a triad of impairments in social communication, repetitive or restricted behaviors, and speech and language delays. The first two features are used for diagnosing ASD according to the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5). Additionally, ASD is often associated with various psychological and physiological comorbidities (Sauer et al., 2021). These can include cognitive deficits, anxiety, depression, attention deficits, hyperactivity, impulsivity, seizures, gastrointestinal issues, sensory processing dysfunction, aggression, metabolic disorders, sleep disorders, motor dysfunction, and altered immune responses. The presence and severity of these symptoms vary widely among individuals with ASD, contributing to significant heterogeneity.

Executive functions, skill generalization across different settings, and organizational skills are notably impacted, causing individuals with ASD to struggle with adapting to new environments, people, and materials. Consequently, difficulties with performing independent behaviors and initiating tasks are significant features of ASD (Grabrucker, 2021).

Speech and Language difficulties in children with ASD

Speech and language difficulties are core features of ASD and can vary widely. These may include delays in speech and language development, atypical language development, speech sound errors, and challenges with social use of speech and language. Speech and language impairments in ASD primarily hinder a child's ability to express basic needs, discomfort, or emotions, significantly impacting their daily life. These challenges may manifest in the following ways:

Social Interaction Challenge

Individuals with ASD face significant social interaction challenges, including a profound sense of isolation, difficulties in initiating social interactions, and communication struggles (Müller, Schuler, & Yates, 2008). They often long for greater intimacy, wish to contribute to their community, and strive for better social and self-awareness. These problems increase in the presence of speech and language delays that affect the child’s ability to communicate needs and understand social cues in children with ASD. This leads to problems in social communication and interaction and therefore results in social isolation and problems in the formation of social relationships from early age (Paul & Cohen, 1984).

Academic Difficulties

Difficulty in comprehending and expressing language can lead to challenges with understanding instructions, participating in classroom discussions, and engaging with educational interactions. As a result, children with speech and language delays are likely to lag behind in school and may require assistance to perform well. These challenges also result in frustration and low self-esteem and therefore affect their education experience significantly (Fleury et al., 2014).

Behavioral Issues

When children cannot communicate effectively, in order to express their needs they may resort to negative behaviors. These negative behaviors may include protest or escape behaviors such as physical resistance, attacks or even meltdowns. Hence, language delays in children with ASD are associated with increased behavioral problems, including frustration and aggression (Matson & Neal, 2010). In ASD, especially in males, increased levels of aggression are associated with poor communication abilities (Neuhaus et al., 2021).

Emotional Regulation Problems

Lack of emotional regulation in individuals with ASD results in behavioral problems such as temper tantrums, aggression, and self-harm especially where the child is overstimulated or stressed (Mazefsky & White, 2014). The speech and language development issues can limit a child’s ability to express one’s own feelings as well as comprehend feelings of others, which can lead to emotional dysregulation (Prizant & Wetherby, 2005).

Long-term Impact on Independence

Effective communication is crucial for independent living. As one’s communicative competence help in securing employment, managing daily tasks, and maintaining social relationships. Language delays can thus have a profound impact on an individual's ability to live independently. This has been supported by a research study carried out by Howlin et al. in 2004, where they found that, individuals with ASD with significant language delays are less likely to achieve independence in adulthood compared to those with better language skills.

While speech and language difficulties broadly affect various aspects of life for individuals with autism, the severity of this impact varies among individuals. The degree of speech and language impairment also differs among children with ASD. Some are verbal and face minimal difficulties, while others remain non-verbal. This variation in communication abilities can significantly influence a child’s social interactions, learning, and overall quality of life.

Minimally verbal children with ASD

The term ‘minimally verbal’ has been viewed in different ways by different authors. Romski et al (2010) defines nonverbal toddlers as those who's Mullen Expressive Language Scores were below 12 months and had a fewer than 10 intelligible spoken words. Yoder and Stone (2006) defines preschoolers as non-verbal or low verbal based on the presence of a fewer than 20 different words used over three separate language samples. In the present study, the term "minimally verbal child" is defined according to Kasari et al. (2013), who describe it as, "The minimally verbal child has a very small repertoire of spoken words or fixed phrases that are used communicatively. The exact number of words may vary across children, from no spoken words or phrases to perhaps 20 or 30..." (Kasari et al., 2013, p. 2).

The proportions of children with ASD who meet the nonverbal, minimal verbal, and verbal criteria are 15%, 10%, 75% respectively (Norrelgen et al., 2014). Thus, a sub-group of children with ASD shows minimal or no progress in verbal expressive language skills despite receiving speech and language therapy. The reasons for this lack of improvement have not been extensively researched, and little is known about why some children with ASD improve in verbal expressive language while others do not. However, some potential factors and characteristics of this sub-group include:

Presence of Childhood Apraxia of Speech or oral-motor impairment along with ASD

Research has found that sub-phenotypes of minimally verbal children with ASD are often characterized by a comorbid motor speech disorder or a combination of motor speech and auditory processing disorders (Chenausky et al., 2019b). Shriberg et al. (2010) proposed the CAS-ASD hypothesis, suggesting that comorbid CAS might be a sufficient cause for nonverbal ASD, and they evaluated this hypothesis. They discovered that, although not all nonverbal children with ASD exhibited core features of CAS, for some children, CAS was the primary factor contributing to their nonverbal status.

Belmonte et al. (2013) evaluated the relationship between motor impairments and speech and language skills in children with ASD. They found that the disparity between receptive and expressive speech/language in nonverbal children with ASD was highly correlated with oral and other motor impairments. The motor-impaired group had lower post-intervention oral motor scores compared to the motor-intact group. They concluded that motor deficits not only strongly correlate with pre-intervention speech-language acquisition levels but also influence the overall learning rate, particularly for expressive language. Additionally, they found that the learning rates for expressive and receptive language were closely linked to the learning rates for oral motor skills.

Sensory processing deficits

It has been found that higher levels of sensory hypo-responsiveness and sensory seeking are both concurrently and predictively associated with nonverbal status in children. Although sensory hyper-responsiveness did not differentiate between verbal and nonverbal children, both sensory hypo-responsiveness and sensory seeking behaviors are inversely associated with language development. Thus, underlying sensory processing significantly influences the prognosis for acquiring verbal expressive language skills (Patten et al., 2013).

Imitation

Pecukonis et al. (2019) investigated the relationship between expressive language and social communication variables such as joint attention, imitation, and play. The results revealed that imitation and play were significantly correlated with expressive language. Although joint attention is generally more correlated with speech and language development in children with ASD, it did not correlate with expressive language acquisition in minimally verbal children with ASD. Instead, play and imitation were significantly correlated with expressive language, with imitation skills being the major predictor of expressive language prognosis.

Restricted consonant and vowel inventory

Yoder et al. (2014) conducted a study to identify predictors of receptive and expressive language development in initially non-verbal children with autism. The results showed that joint attention, intentional communication, and parent linguistic responses were significant predictors of growth in both expressive and receptive spoken language. Additionally, they reported that the early receptive vocabulary and autism severity acted as significant predictors for the development of receptive language, while consonant inventory for expressive language. This study was further supported by research conducted by Saul and Norbury (2020), which showed that both the variety of consonant sounds produced and the phonetic repertoire were important predictors of expressive language development. However, in the latter study factors such as communicative intent, parent responsiveness, and response to joint attention were not found to predict growth or outcomes in expressive language.

Factors affecting the therapy for children with ASD

Alongside the speech and language deficits, the presence of social communication skills and restricted behaviors constitute the other two core deficits of ASD. Social communication is how and why language is used to interact with other people. Communication decisions are influenced by our location, the people present, and the purpose of our interaction. These decisions are acquired through direct instruction (for example, being advised to say "please" while making a request) and through personal experiences (such as observing when someone is disinterested in a conversation topic). This skill of making appropriate communication choices is known as social communication (American Speech-Language-Hearing Association, n.d.).

Restricted and fixated interests also known as restricted repetitive behaviors are a class of behaviors characterized by high frequency, repetition, and an insistence or desire for sameness in the environment. They can be both stereotyped actions such as hand flapping and rocking of the body, and verbal behaviors such as repetitive words and phrases. Individuals with ASD also tend to have specific or restricted interests. For example, intense interest in a certain topic, sensory fixations on a particular object, or adherence to a specific routine or method of doing a task (Chaxiong et al., 2022).

Deficits in social communication and the presence of restricted repetitive behaviors significantly impact a child's life. These issues can manifest in various ways.

Limited Joint Attention

Limited joint attention is a common challenge for children with ASD. Unlike typically developing children who learn new skills through observation and imitation, children with ASD often require explicit teaching. This limitation affects their early play and interaction skills, hindering their ability to engage in typical leisure activities and form friendships later in life. The need for direct instruction can impede the natural development of social and communicative abilities (Charman, 2003).

Anxiety in Social Interactions

Anxiety in social interactions is prevalent among children with ASD, reducing their engagement in leisure activities and leading to the avoidance of social opportunities. This anxiety complicates their ability to work as part of a team, particularly during social times such as in school playgrounds or workplace staff rooms or even in therapy settings. Their reliance on technology for interaction can pose personal safety risks and contribute to social withdrawal, which in turn affects their mental health and emotional wellbeing (Montaser et al., 2023).

Absent or Fleeting Eye Contact

Absent or fleeting eye contact is a significant issue for children with ASD. While this challenge affects them primarily in public settings, such as difficulty during ordering food or requesting assistance. It also hinders their ability to engage in one-on-one interactions such as greeting, initiate conversations, and forming friendships. The lack of sustained eye contact can be a barrier to effective communication and social bonding, further isolating them from their peers and the broader community (Thorsson et al., 2024). In therapeutic intervention, these issues can hinder language learning because major learning happens through imitation and observation. Treating speech sound errors can be even more challenging, where visual cues and the observation of speech motor movements are essential.

Avoidance of new environment and preference for familiar activities

Avoidance of new environment is exhibited in terms of reluctance to use community facilities like leisure centers and libraries, and anxiety about starting work or employment or changes in therapy environment. Hence children with ASD might prefer going to familiar places and doing familiar tasks over exploring new options. In the context of therapy such preferences for familiar activities results in limited opportunities to develop new skills, lack of motivation to learn new tasks or participate in therapeutic activities (Sevin et al., 2015).

Along with these core deficits, children with ASD may also experience differences in sensory processing. Such processing differences or deficits are not confined to a single sense such as visual or auditory, but can affect multiple sensory domains simultaneously (Thye et al., 2018). Hence, children with ASD might face certain challenges due to the presence of these sensory processing differences.

Dislike or avoidance of certain sensory stimuli

Children with ASD can be triggered by specific types or intensities of sensory stimuli, including tactile, visual and auditory inputs. Sensory hypo-responsiveness involves reduced sensitivity, where individuals may need more intense stimuli to elicit a response. In contrast, hyper-responsiveness manifests as heightened sensitivity, leading to anxiety, physical discomfort, irritability, or even pain. This sensory overload can result in emotional and behavioral reactions, such as withdrawal, distress, or meltdowns (Zauderer, 2023). This challenge extends to therapy settings, where both the materials used for training and the therapy room itself may need to be tailored to accommodate the child's sensory needs. Additionally, tactile or motor kinesthetic cues used during speech sound training may not be well-received by all children and should be adjusted according to each child's level of need and acceptance.

Sensory seeking behaviors

Children with ASD may exhibit behaviors like pacing, rocking, or fidgeting. They might struggle with quiet, passive activities such as hairdresser visits, office work, or restaurant dining or even therapy activities. Hence, they require sensory breaks, like movement breaks, to maintain alertness and concentration (Morin, 2023).

Thus, on a whole it is crucial to consider all these above challenges faced by children with ASD while selecting therapy strategies and setting goals or planning activities for therapy sessions as they significantly impact therapy sessions. Neglecting to address these challenges can lead to ineffective therapy and hinder the development of a strong bond between the child and therapist, ultimately affecting the long-term success of the therapy. Therefore, it is necessary to choose a therapy approach that addresses all these issues.

Further, functional play activities, parental involvement, incorporating breaks during therapy sessions, dividing therapy into smaller, manageable segments, and using strategies like visual scheduling have all been found to effectively reduce a child's frustration and enhance the overall effectiveness of therapy by addressing most of the previously mentioned issues. Although the combined effect of all these strategies has not been thoroughly investigated, each strategy individually has been shown to increase the efficiency of therapy sessions.

Functional play activities

Functional play activities have been increasingly recognized as effective interventions for children with ASD, offering several advantages over traditional trail-based therapy. Here are some studies supporting these advantages:

Real-world applicability: It is found that a play-based intervention, incorporating functional play activities, resulted in significant improvements in social play skills of children with ASD, indicating the real-world applicability of such interventions (Elbeltagi et al., 2023).

Engagement and motivation: Play-based program, which included functional play activities, have found to lead to increased engagement and motivation in children with autism, fostering greater social interaction skills (Wuang et al., 2011). This in turn can be helpful in establishing joint attention, which is a primary factor in success of speech and language therapy in minimally verbal children with autism.

Development of multiple skills: "Improving social play skills in children with autism using an interactive robot" (Kim et al., 2013) showed that a play-based intervention utilizing an interactive robot resulted in improvements not only in social play skills but also in language and cognitive skills in children with autism, highlighting the development of multiple skills through functional play activities.

Thus, functional play activities are advantageous in promoting various skills and outcomes for children with ASD, including social interaction, communication, and engagement. Hence, need to be incorporated into therapeutic interventions.

Parent involvement in therapy:

Play-based activities are found to be more effective when they are combined with parent mediated intervention:

Enhancing the joint attention: Training parents how to use specific techniques during everyday interactions with their infants will promote social communication. These simple techniques involve the use of responsive and contingent interactions and following the child's lead. This was found to enhance joint attention during play (Green et al., 2015).

Improved outcomes: It was found that infants who received the parent-mediated intervention showed improved outcomes compared to those who received no intervention. These improvements were observed in various areas, including social communication skills, language development, and adaptive behavior (Meindl, 2014).

Builds supportive environment for communication: Parents play a vital role in their child's development, especially in the early identification and intervention for ASD. Educating the parents on strategies to effectively communicate with their children and training them on how to build effective bonding through play-based activities, can help to create a supportive and enriching environment for their infants' growth (Kashinath, Woods, & Goldstein, 2006).

Generalization of skills: One of the advantages of a parent-mediated intervention when combined with play-based activities is its potential for promoting generalization of skills beyond the therapy setting. Because this involves, training the parents on therapy strategies and educating them about importance of modifying the environment, while also assisting them in integrating intervention strategies into everyday routines and activities. Thus, with adequate support from the therapists, parents can reinforce and extend their child's learning into naturalistic contexts, leading to better maintenance of progress over time (Meadan et al., 2009).

Higher parent satisfaction: Edwards et al. (2016) conducted a research study where they interviewed the parents of children with ASD for what they expect out speech therapy for their children. They identified that parent appreciate when they are informed about therapy goals, strategies and reasoning behind opting these. Thus, it was found that, when therapists collaborated with families, it helped in building strong therapeutic relationships with parents, and also resulted in higher parent satisfaction with the therapy services.

Breaks during therapy sessions and dividing therapy into smaller, manageable segments

Incorporating breaks into therapy sessions for children with ASD has been shown to provide multiple benefits. It enhances both the child’s engagement and the overall effectiveness of the therapy. The literature review for the same are as follows:

Reduction of Sensory Overload: Children with ASD often experience sensory overload due to their heightened sensitivity to sensory stimuli. Breaks help in mitigating sensory overload by allowing the child to step away from a stimulating environment, thus reducing stress and anxiety (Baranek et al., 2005).

Improved Attention and Focus: Continuous involvement in particular activity without any breaks can lead to reduced attention spans and also increase distractibility. Thus incorporating short, regular breaks can help maintain and improve attention and focus in children with ASD during therapy sessions (Schreibman et al., 2000).

Behavioral Regulation: Children with ASD often indulge in certain self-soothing behaviors that help to regulate themselves. Proving breaks provide gives them opportunity engage in such activities, which can help regulate their emotions and behaviors. Thus, scheduled breaks help in reducing challenging behaviors and meltdowns by giving the child a chance to calm down and reset (Koegel et al., 2010).

Enhanced Learning and Retention: Taking breaks often can assist in the formation of knowledge and avoid overloading brain with abundant information. Studies indicate that breaking up therapy sessions into smaller, more manageable segments can improve the child's ability to retain and apply new skills (Kasari et al., 2006).

Increased Engagement and Motivation: Breaks can be used as a form of positive reinforcement, motivating children to engage in therapeutic activities. Research shows that incorporating breaks as a reward for completing tasks can enhance the child's willingness to participate and maintain engagement in therapy (McGarry et al., 2013).

Visual scheduling

Visual scheduling is a widely recognized and effective tool in the therapy and education of individuals with ASD. It utilizes visual cues to help individuals understand and predict the sequence of activities. This can significantly enhance their ability to manage daily tasks and reduce anxiety.

Enhancing Predictability and Reducing Anxiety: Research indicates that children with ASD often experience high levels of anxiety due to the unpredictability of their environment (Banda et al., 2009). Thus, visual schedules assist in making daily routines predictable for individuals with ASD. They help to schedules thus providing a clear and concrete representation of what to expect, which can prevent anxiety and improve their ability to transition between activities.

Improving Task Compliance and Engagement: According to MacDuff, Krantz, and McClannahan (1993), visual schedules help children with ASD understand what is expected of them, increasing their willingness to participate in activities. This is particularly effective in educational settings where children may struggle to follow verbal instructions. However, these observation can be generalized to therapy settings as well, as visual schedules can be utilized to plan the activities for the child in prior, making it more predictable and thus increasing their willingness to involve in the activities carried out during therapy session.

Supporting Communication and Independence: Visual schedules also enhance communication and promote independence among individuals with ASD. Research by Dettmer et al. (2000) suggests that various types of visual supports, including schedules, can serve as an alternative means of communication for non-verbal children or those with limited verbal skills. These tools empower children to understand their routines and express their needs, thus increasing independence in activities daily living.

Reducing Challenging Behaviors: The implementation of visual schedules can also assist reducing challenging behaviors. A study by Bryan and Gast (2000) found that when children with ASD were provided with visual schedules, there was a noticeable decrease in behaviors such as tantrums and non-compliance. The predictability offered by visual schedules helps to reduce the frustration and confusion that often the cause for these behaviors.

Facilitating Transitions and Flexibility: Visual schedules are particularly effective in assisting transitions from one activity to other and aids in bringing in more flexibility. Children with ASD often struggle with changes in routine. A study by Sterling-Turner and Jordan (2007) demonstrated that visual schedules can help children adapt to changes more smoothly by providing a visual cue for what is coming next, thereby easing the transition process.

Therefore, the use of visual schedules is justified by the available literature, which emphasizes the importance of providing structure and support for people with ASD. While efficacy of integrating visual schedules with speech therapy has not been studied, the use of the visual schedule remains an important aspect in managing the needs children with ASD during therapeutic intervention.

In addition to the strategies mentioned above, it is important to note that for the target population of the present study—minimally verbal children with autism—providing speech motor cues plays a crucial role (Chenausky et al., 2019).

Speech motor cues

Speech motor cues provide important sensory feedback, facilitating the production of speech sounds. By focusing on motor cues, therapists can tailor interventions to address specific speech production challenges, ultimately helping children improve their ability to communicate effectively. Although there have not been many evidences of use of speech motor cues in the target population, it's effectiveness in speech sound disorders has been studied extensively showing positive results. Shriberg et al. (2010) emphasize the importance of motor learning in speech sound production. Thus, in case on presence of motor impairment in minimally verbal children with ASD (Chenausky et al., 2021) speech motor cuing can be effective in facilitating their speech production.

Video models

Video modeling has been found to be useful in ASD treatment since it involves the use of videos to demonstrate the required behaviors, social skills, and communication techniques. It can promote learning and generalization of skills in children with ASD by providing well defined, repetitive and fun learning activities. Also, it enables the flexibility of the learning process and can be adapted to the learner’s speed and preferences (Bellini & Akullian, 2007). Degree of effectiveness of video models may vary depending on factors such as the individual's level of functioning, the specific goals of therapy, and the quality of video modeling interventions implemented. However, research has shown that visual models aid in improving social interaction, faster acquisition of targeted skills and reducing problem behaviors, the literature support for the same is as follows:

Social Initiation: Charlop-Christy, M. H., & Daneshvar, S. (2003) demonstrated the effectiveness of video modeling in teaching social skills to children with autism. Results showed that video modeling was more effective than a control condition in improving social initiations and responses.

Faster skill acquisition: Nikopoulos, C. K., & Keenan, M. (2007) found that video modeling was effective in teaching various skills, including play and social behaviors, to children with autism. Video modeling resulted in increased skill acquisition and maintenance compared to traditional instruction methods.

Reduction of problem behavior: Bellini, S., & Akullian, J. (2007) examined the use of video modeling to teach social skills to children with ASD and found that video modeling was effective in increasing targeted social behaviors and reducing problem behaviors in social situations.

In par and live model for social skills development: Whalen, C., Schreibman, L., & Ingersoll, B. (2006) compared the effectiveness of video modeling and live modeling in teaching social skills to children with autism. Both methods were found to be effective, with video modeling demonstrating comparable outcomes to live modeling.

Therapy for minimally verbal children with ASD

As discussed earlier in the review, minimally verbal children with ASD are characterized by, sensory processing deficits, difficulties in imitation skills, restricted consonant and vowel inventory and possible presence of Childhood Apraxia of Speech or oral-motor impairment along with ASD. Hence, this population requires unique assessment and intervention compared to their verbal counterparts. There are a very few researches related to treatment strategies and treatment efficacy in this subgroup of ASD. Treatment approaches such as PROMPT, Denver Model and AMMT have been researched and found to have positive impact on speech and language skills in this population.

The study by Rogers et al. (2006) compared the Denver Model and PROMPT interventions for teaching speech to young, nonverbal children with autism, emphasizing developmental orientation, parent involvement, and daily practice. Both interventions were effective in enhancing speech production and communicative abilities. It highlighted the holistic approach to speech development, including nonverbal communication, imitation, and receptive language. Although the Denver Model is a holistic approach and PROMPT primarily focuses on speech motor control, the resulting measures were not found to be different, suggesting that both could be beneficial depending on the individual needs of the child. However, the study did not address how these two techniques impacted specific measures such as stimulability to speech sounds, or consonant and vowel inventory.

Wan et al. (2011) conducted a proof-of-concept study on AMMT, involving 8 weeks of intensive therapy with five sessions per week. AMMT involves steps such as unison production, partially-supported production, immediate repetition, and own production. This approach primarily relies on auditory-motor mapping through bimanual tapping. This study showed that AMMT can significantly improve the consonant and vowel inventory of nonverbal children with autism. And it enables them to produce a wider range of speech sounds and approximate words, which is a critical step towards expressive language development. While AMMT prioritizes a structured approach and intensive repetition, it does not emphasize parent-child interaction or training to use the target word in a functional context. Also, it involves conducting five sessions per week over an 8-week period, which represents a highly intensive therapy regimen that can be practically challenging while implementing the approach.

Vashdi, E. (2016), investigated the efficacy of the Initial Phoneme Cue (IPC) technique for a 10-year-old minimally verbal child who was diagnosed with Childhood Apraxia of Speech (CAS) and ASD. This case study compared word imitation success rates between IPC and regular imitation methods. It revealed that IPC was remarkably successful with a 100% word imitation rate, in contrast to 0-20% with regular methods. IPC significantly improved the patient's ability to articulate words, suggesting its potential as an effective treatment approach for CAS, particularly in cases involving autism. Although this study measures the improvement in a child's ability to imitate words, it does not emphasize the technique's impact on the child's consonant and vowel repertoire or overall verbal expressive repertoire. It primarily addresses the CAS component without focusing on the adaptations needed for the presence of ASD.

Therefore, there is need for an approach that can addresses the unique characteristics of minimally verbal children with ASD, such as oral-motor impairments and a limited consonant repertoire. Additionally, the approach must accommodate all factors that impact their therapy due to the presence of ASD features.

As discussed previously, several factors can impact therapy for children with ASD, including limited joint attention, anxiety in social interactions, absent or fleeting eye contact, limited generalization skills, avoidance of certain sensory stimuli, and sensory-seeking behaviors. However, these have not been addressed in Denver Model, PROMPT, AMMT, and IPC. To address these challenges, various strategies have proven effective, such as using visual schedules, video models, play-based activities, promoting parent-child interaction, dividing session into manageable smaller segments and providing structured breaks during sessions. These strategies enhance joint attention and motivation, help regulate the child's behavior during therapy, and improve the overall outcomes of the therapy.

The ACT4CAS, developed by Beiting and Maas (2021), represents a novel therapeutic intervention that systematically incorporates all of the techniques mentioned earlier. It is specifically designed for children with both ASD and CAS to provide effective speech intervention (Beiting & Maas, 2021). In their foundational study, the authors describe the ACT4CAS treatment procedure, focusing on two specific target words for intervention. The therapy session starts with a review of the visual schedule, the selection of reinforcers, and the administration of probes (each lasting up to 10 minutes). One of the target words then receives 10 minutes of blocked, drill-based practice followed by 10 minutes of play-based practice. After a break of up to 10 minutes, the same approach is used for the second target word. Each session lasts between 50 and 60 minutes in total. The objectives of this treatment approach involves enhancing articulation, promoting the maintenance and generalization of improvements, and reducing the likelihood of participant distress.

The ACT4CAS approach integrates principles of motor learning (PML; Maas et al., 2008) and carefully selects treatment targets based on the child's phonetic repertoire and phonotactic abilities to improve articulatory skills. It uses smaller segments of 10 minutes for drill-based practice and 10 minutes for play-based activities. Hence, the intervention is divided into small manageable parts and include breaks between sessions. The drill-based practice ensures high-frequency practice to address oral motor deficits, while incorporating variable video models to increase the motivation and reduce problematic behaviors in children with ASD (Dunlap & Koegel, 1980). It also involves choosing target words on the basis of their functional utility and embedding them into play-based practice to enhance maintenance and generalization (Beiting & Maas, 2021). Further, the play-based practice involves parent participation that encourages parent-child interaction and educates the parent on therapy techniques, facilitating their use at home or in different settings. The components of the approach have been described in the Table 1.

Table 1

Overview and justification for key components of Autism-Centered Therapy for Childhood Apraxia of Speech

Component	Rationale
Drill-based practice	• Typically results in more production attempts than play-based approaches • High frequency practice essential for establishing new motor plans • Short bursts of practice (10-min block with breaks), maintains attention

Table 1 (continued).

Play-based practice	• Counterbalances the artificiality of drill-based practice • Incorporation of caregivers facilitates high-quality home practice • Uses motivating toys, thereby reducing frustration • Increases likelihood of generalization
Functional treatment targets	• Highly motivating, facilitates participant engagement • Increases likelihood of family “buy-in” • Natural opportunities for home practice
Prerecorded video models	• Decreases reliance on in vivo models/eye contact, reduces distractions • Allows for variations in presentation (e.g., slowed rate) and highlighting of key features (e.g., zooming in on the mouth) • Able to train multiple exemplars through use of varied speakers • Allows for quick interspersal of real-world example of target use to improve comprehension and understanding of use
Visual support	• Paired pictures and video examples with targets improves language comprehension • Picture schedules increase session predictability and reduce frustration
Prompt hierarchy	• Essential for avoiding negative practice when forming new motor plans • Increases likelihood of successful productions and subsequent positive internal and external feedback
Preference assessment and frequent rewards	• Quickly identifies optimal reinforcers • Reduces likelihood of frustration

Note. Retrieved from Beiting M, Maas E. Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS): A Single-Case Experimental Design Study. Am J Speech Lang Pathol. 2021 Jun 18;30(3S):1525-1541. doi: 10.1044/2020_AJSLP-20-00131. Epub 2021 Mar 8. PMID: 33684309.

To date, only one study has been conducted on ACT4CAS, conducted by its original authors. This foundational research utilized a multiple-baseline design both within and across participants. Three minimally verbal children diagnosed with both ASD and CAS received intervention. Two specifically tailored treatment target words were selected for intervention. Across 11-18 sessions, these treatment targets were compared against untreated control words. Changes in speech production accuracy and variability were perceptually assessed through visual inspection and quantified using effect sizes. The study resulted were mixed, as one child demonstrated significant improvements in half of the treated targets, while the other two children did not show clear improvements. Nonetheless, preliminary evidence indicated potential positive effects of ACT4CAS.

However, the impact of ACT4CAS on consonant and vowel inventories of the participants hasn't been thoroughly investigated. Additionally, there is no indication of whether the changes in speech parameters have resulted in any improvements in communication skills. Changes in phonetic inventory resulting from therapeutic interventions are highly significant as research has consistently shown that strong speech production skills and a broad consonant inventory are critical components in the language development in children with ASD (Saul & Norbury, 2020). Also, Brady et al. (2021) found that assessing the phonemic inventory in minimally verbal children with ASD can serve as a valuable indicator for predicting their spoken language outcomes. They highlighted that measures such as phonemic scoring can be used as major tool for evaluating the effectiveness of an intervention and making decisions about whether to continue with the current approach or make necessary adjustments or replacements.

Children with ASD also show major difficulty in both gross motor and fine motor imitation (Bravo & Schwartz, 2021). Imitation is an integral part of developmental process and is a crucial skill in both speech and language acquisition (Bloom et al., 1974). Possibility of presence of speech motor production deficits in minimally verbal children with ASD further complicates the imitation of speech for these children, even with the support of multi modal cues. Hence, any enhancement in the capacity to imitate speech sounds or stimulability to speech sound production can be a significant indicator of progress in acquiring speech sounds.

Thus, it is crucial to examine the potential positive impact that ACT4CAS could exert on parameters such as consonant and vowel inventories, stimulability to speech sound production. Since improvement in speech production skills are known to correlate with improvements in language abilities (Saul & Norbury, 2020), it is essential to examine the influence of ACT4CAS on the social communication and language skills of minimally verbal children with ASD as well. Consequently, the current study aimed to find the effect of ACT4CAS on speech and language skills in minimally verbal children with ASD by evaluating these measures.

CHAPTER III

METHOD

Case study method involving pre-post comparison was employed to test the effect of ACT4CAS on speech and language skills in minimally verbal children with ASD. The reasons for employing case study method involving pre- post comparison is as follows:

1. The case study approach allows for flexibility in the research methodology, which is crucial given the diverse nature of the target population (minimally verbal children with ASD) in the current study, necessitating customized interventions for each individual (Crowe et al., 2011).
2. The case study approach allows for a detailed qualitative assessment over time, emphasizing natural processes rather than controlled experimental outcomes (Crowe et al., 2011). Given that the present study involves measuring dependent variables such as consonant and verbal inventory, verbal expressive repertoire, and responsiveness to speech sounds, which are more effectively analyzed qualitatively, the case study approach is particularly suitable.
3. The case study is well-suited when the investigator has limited control over events, and employing withdrawal and reversal strategies is impractical due to potential negative impacts on participants (Schell, 1992). Since the present study evaluates the effects of an intervention approach that combines multiple techniques, it is challenging to control all variables. Consequently, it is feasible to assess target measures without stringent control over all variables. Given the potential negative impact of therapy withdrawal on the target population, only pre-post comparisons can be employed effectively.

4. Enable a precise evaluation of the impact of the intervention on an individual unlike evaluation of average performance in group design (Harrington & Velicer, 2015). Given the diverse responses to treatment approaches within the ASD population, despite similar overarching symptom manifestations (Warren et al., 2011), it is crucial to assess how each participant is uniquely affected by the therapy approach.
5. It can be utilized for populations that are challenging to recruit in sufficient numbers to facilitate a group-level design (Gallo et al., 2013). Minimally verbal children with ASD constitute a subgroup that is seldom encountered and limited in size. Moreover, these individuals typically present with diverse symptom profiles, making it impractical to form age- or gender-matched groups.

Participants

Three children in the age range of 4-10 years whose native language is Kannada and are diagnosed with ASD were included in the study. Participants were selected based on convenience and purposive sampling criteria, considering the following inclusion and exclusion criteria.

Inclusion criteria

1. Children should be diagnosed with ASD by a qualified Speech Language Pathologist based on Diagnostic and Statistical Manual of Mental Disorders-V (Ewer, 2013) and/or standardized test material such as Indian Scale for Assessment of Autism (ISSA) criteria.
2. Should have an Average Intellectual Functioning as assessed by a qualified Clinical Psychologist.
3. Children who have previously taken regular Speech Language Therapy and/or

Augmentative Alternative Communication for a span of 3 months or more and have found minimal or no improvement in verbal expression.

4. According to the definition of “minimally verbal” children, those children who have fewer than 30 functional words in their verbal expressive repertoire or who are unable to use speech alone to communicate, or both will be chosen for the study (Kasari et al., 2013).

Exclusion criteria

1. Children with other comorbidities such as Hearing Impairment, Visual Impairment, Cerebral Palsy, Attention Deficit Hyperactivity Disorder, gross motor weakness, Intellectual Disability, epilepsy and/or associated syndromes. However, it should be noted that participant P3 was included in the study despite having Borderline Intellectual Functioning, due to limited availability of cases meeting all criteria and time constraints for the study.
2. Children who have not taken any speech therapy previously or have expressive verbal repertoire or greater than 30 functional words

The details of the participants are given in the Table 2.

Table 2

Participant details

Participants	**Age/Gender**	**Diagnosis**	**Intelligence Quotient**
Participant 1 (P1)	5 years / Male	SLD* secondary to ASD	93
Participant 2 (P2)	4 years / Male	SLD secondary to ASD	90
Participant 3 (P3)	7 years / Male	SLD secondary to ASD with BIF^	80

Note. *Spoken Language Disorder
^Borderline Intellectual Functioning

Ethical clearances

Prior consent for participation of children in the study was obtained from the caretakers in written and verbal format, adhering to the institutional board Ethical Guidelines for Bio-Behavioral Research Involving Human Subjects (*Venkatesan* & *Basavaraj*, 2009). Sample of consent letter is given in Appendix C. Permission for carrying out the study in the Institute was obtained from the respective authorities.

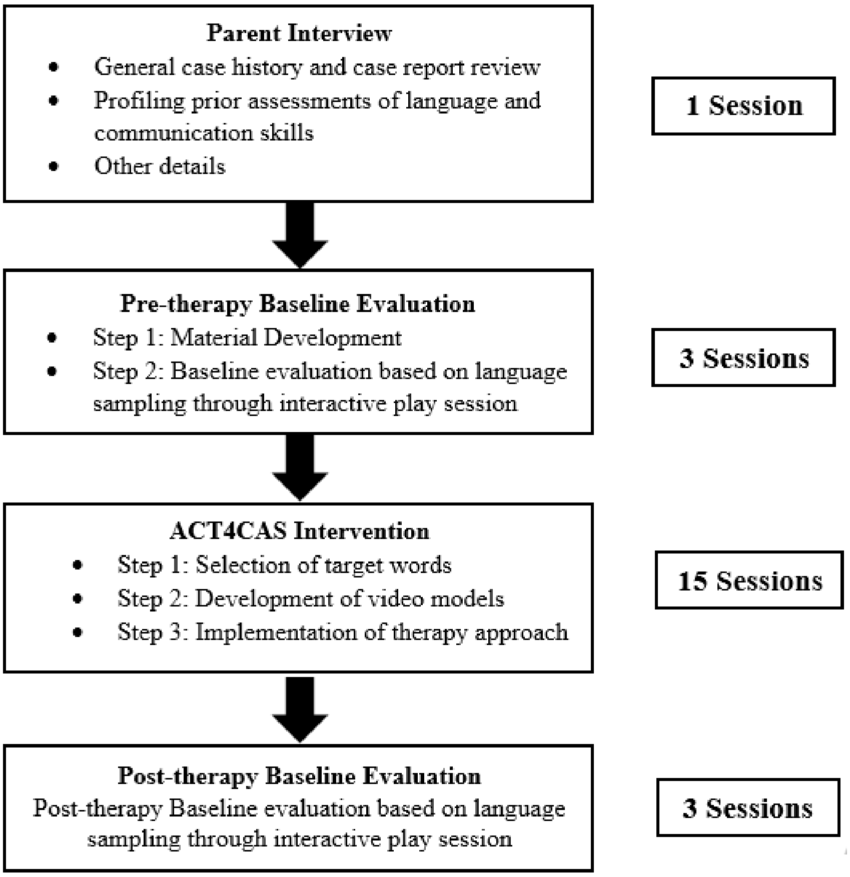
Overview of application of ACT4CAS approach

The present study was conducted over a period of 7 weeks, comprising 22 sessions, with three sessions held each week. The initial session was dedicated to interviewing the caretaker and reviewing the case report in their presence. The subsequent three sessions involved pre-therapy baseline assessments to obtain measures of the dependent variables. Following this, the ACT4CAS intervention was administered. After the first 7 intervention sessions, a mid-baseline assessment was conducted, followed by another 7 sessions of the ACT4CAS intervention. The final three sessions were devoted to post-therapy baseline assessments to obtain measures of the independent variables. The study procedure is illustrated in Figure 1.

The Samsung Galaxy S23 camera, equipped with specification of 50MP sensor, f/1.8 aperture, 24mm focal length, 1/1.56” sensor size, 1.0µm pixel size, dual pixel PDAF, and OIS, was used to record all sessions for evaluating the child's responses and developing video models.

Figure 1

Overview of study procedure



Parent Interview

In the first session, the case report was reviewed, and previous assessments of speech, language, and communication skills were reviewed. General case history and the participant’s current speech, language, and communication abilities were gathered through parent (mother) interview. Information regarding the child's social interaction skills, sensory sensitivities, behavioral issues, and play preferences were also collected. Additionally, the child's preferences and dislikes were noted to identify potential strategies for reinforcement.

Pre-therapy Baseline Evaluation

Based on the parent interview, play activities for interactive sessions and picture stimuli to assess responsiveness to speech sounds were designed. An interactive play session was conducted for language sampling. Numerous opportunities were given to express requests, make comments, or refuse play/toys during the play session in order to maximize the potential for eliciting a wide range of verbal expressions. Thus, the pre-therapy baseline evaluation process was carried out in two steps. The first step involved developing materials to be utilized during evaluation and the next step was baseline evaluation.

Step 1: Material Development

The play materials used in interactive play sessions during the baseline evaluation: The play materials were designed to evoke all conceivable speech sounds in the Kannada language. The list of play toys and the possible speech sounds that they evoke are listed in Table 3. The same toy materials were to be used flexibly in various contexts to stimulate verbal expressive repertoire.

The picture stimuli for assessing stimulability to speech sound production during the baseline evaluation: A set of pictures were compiled, each focusing on a specific speech sound in the Kannada language, ensuring that each picture stimulus targets a single speech sound. The selection of pictures ensured that the target speech sound was integrated into the initial position of a word that can be visually represented. The list of pictures and the possible target speech sound evoked are listed in Table 3.

Table 3

Toy materials and picture stimuli to elicit target sounds

Target sound	Toy materials that might possibly elicit the target sound		Picture stimuli to elicit the target word	
	Toy/ Actions/ Cards	Target word in Kannada/English	Picture	Target word in Kannada/ English
/k/	Car Carrot	/kaːru/ /kærret/	Car Crow Empty box	/kaːru/ /kaːge/ /kʰaːli/
/g/	Grapes Gum	/greːps/ /gam/	Doll Clock Beard Bell	/gombe/ /gaɖijaːra/ /gaɖɖa/ /gʱanʈe/
/c/	Butterfly Chair	/tʃiʈːe/ /tʃajr/	Butterfly Chair Slippers Mat	/tʃiʈːe/ /tʃajr/ /tʃappali/ /tʃaːpe/
/dz/	Jar	/dʒaːr/	Braid Deer Swing	/dʒaɖe/ /dʒinke/ /dʒoːkaːli/
/t̟/	Tomato Teddy bear Tiger	/ʈomæːʈo/ /ʈeɖɖi beːr/ /ʈajgar/	T V Goat Hat	/ʈiːʋi/ /ʈagaru/ /ʈopːi/
/d̟/	Duck Door Dice	/ɖak/ /ɖoːr/ /ɖajs/	Box Drum	/ɖabba/ /ɖoːlu/
/n̟/	Mud House fly	/maɳɳu/ /noɳa/	Beads	/maɳi/
/t/	Plate Head	/t̪aʈʈe/ /t̪ale/	Plate Wrong	/t̪aʈʈe/ /t̪appu/
/d/	Big Thread	/d̪appa/ /d̪aːra/	Big elephant Cow	/d̪appa/ /d̪ana/
/n/	Number coin-four	/naːlku/	Dog Tap	/naːji/ /nalli/
/p/	Pan Popping the bubble	/pæːn/ /pɔpɔp/	Baby Poori	/paːpu/ /puːri/
/b/	Ball Bubble Book	/bɔl/ /babal/ /buk/	Ball Shirt and pant Bus	/bɔl/ /baʈʈe/ /bas/
/m/	Monkey Fish	/manga/ /miːnu/	House Tree Mango	/mane/ /mara/ /maːʋu/
/j/	Who?	/jaːru/	Who?	/jaːru/
/r/	Ring Red	/ring/ /reɖ/	Rocket Rangoli	/rɔkeʈ/ /rangoːli/

Table 3 (continued)

/l/	Lion	/lajan/	Glass	/loːʈa/
	Light	/lajʈ/	Lorry	/lɔːri/
/v/	Watch	/ʋaːtʃ/	Watch	/ʋaːtʃ/
			Vada	/ʋaɖe/
/S/ (palato-alveolar or alveolo-palatal)	Cooker sound	/ʃ/	Shampoo	/ʃuːæmpu/
	Shirt	/ʃart/	Shoe	/ʃuː/
			Shell	/ʃankʰa/
/s/	Spoon	/spuːn/	Curry	/saːmbaːr/
	Snail	/snejl/	Soap	/soːpu/
			Right	/sari/
/h/	Put	/haːku/	Milk	/haːlu/
	Eye brow	/hubbu/	Sing	/haːɖu/
			Waving hand	/haːj/
/l̟/	Bangle	/baɭe/	Rain	/maɭe/
	Banana	/baːɭe/		

Based on the parent interview, any materials that could be excessively distracting or cause fear in the child were substituted with appropriate alternatives. For P1 slime shapes were included, for P2 flip books and alphabets were included, and for P3, activities of stalking the cups, sticking pictures and pulling were included.

Step 2: Baseline Evaluation

Once the consent was obtained and initial interview was completed, the next three sessions were dedicated for clinician directed interactive play sessions for language sampling. During this baseline evaluation, the following dependent measures were measured:

Verbal expressive repertoire: It is the range and complexity of spoken language abilities that an individual can employ to express thoughts, needs, emotions, and engage in interactions (Chan et al., 2005). Using language sampling and parent interviews, the words used by the child were profiled, and the syllable shapes of these words were noted to assess the participants' verbal expressive levels (Tager-Flusberg et al., 2009). To estimate the words in the child's verbal expressive repertoire, both the consistency with which the child used the same utterance without variability to convey a message and the frequency of its use to express a need or message were considered. The frequency was calculated by dividing the number of times the child used an utterance to communicate by the total number of opportunities given to the child to express. Any word used with a frequency of 50% or more to convey a particular message without any variability was considered to be a part of the verbal expressive repertoire (VER). The verbal expressive repertoire for each of the participants is given in Table 4.

Table 4

Pre-therapy verbal expressive repertoire of participants

Participant	**Verbal expressive repertoire (VER) and other utterances**	**Syllable shape of the respective words (SS)**
P1	Meaningful: None	-
	Non-Meaningful: /ama/, /appa/, /ba/, /pa/, /papu/, /nana/- Only reported to produce rarely and were not observed during the evaluation.	VCV, VCCV, CV, CVCV, CVCV
P2	Meaningful: None.	-
	Non-Meaningful: /amma/ (as reported), /ba/, /bi/, /pa/, /mi/ (observed during evaluation).	VCCV, CV
P3	Meaningful: None	-
	Non-Meaningful: /amma/, /baːj/, /ba/, /mama/, /a/, /i/, /ai/. Only reported and were not observed during the evaluation.	VCCV, CVCV, CV

Social communication and language measures: The child's social communication and language abilities was evaluated using the Communication DEALL Developmental Checklists (Karanth P, 2007). The Receptive Language, Expressive Language, Cognitive Skills, and Social Skills domains were measured and the values of the same for each participant are given in Table 5.

Table 5

Pre-therapy social communication and language measures of participants.

Participant	**Receptive language age (RLA)**	**Expressive language age (ELA)**	**Cognitive skills (CS)**	**Social skills (SS)**
P1	Scattered between 18-24 m^ to 24-30 m	06-12 m	30-36 m	12-18 m
P2	Scattered between 18-24 m to 24-30 m	06-12 m	30-36 m	Scattered between 12-18 m and 18-24 m
P3	Scattered between 24-30 m to 30-36 m	06-12 m	30-36 m	18-24 m

Note. ^months

Consonant inventory: A phonetic inventory of consonants is part of an independent analysis of a child's phonological system, revealing the sounds produced by the child regardless of correctness relative to the target (Elbert & Gierut, 1986; Powell & Miccio, 1996) and providing the set of sounds that are available to the child for forming words (Stokes, Klee, Carson, & Carson, 2005). Only sounds that a child produces spontaneously are attributed to the child's phonetic inventory; sounds that are produced only in response to auditory and/or visual stimulation are not considered to be in the child's phonetic inventory (Powell & Miccio, 1996). The consonant inventory of each participant in the present study is listed in Table 6.

Table 6

Pre-therapy consonant inventory of participants

Participant	**Consonant inventory (CI)**	**Remark**
P1	Nil	Production of /p/, /b/ sounds observed during random vocalizations.
P2	Nil	Production of /p/, /b/, /m/ sounds observed during random vocalizations.
P3	Nil	-

Vowel Inventory: Vowel inventory is a list of the different vowel sounds that a child can make, regardless of whether they are correct or errors (*Vowel Disorders and Children With CAS - Apraxia Kids*, 2018). The vowel inventory of each of the participant is given in Table 7.

Table 7

Pre-therapy vowel inventory of participants.

Participant	**Vowel inventory (VI)**	**Remark**
P1	Nil	Random vocalizations consists of /a/, /e/, /u/ sounds
P2	Nil	Random vocalizations consists of /a/, /i/, /u/, /o/ sounds
P3	Nil	Random vocalizations consists of /a/, /i/ sounds

Stimulability to speech sound production: Stimulability assessment aims to determine the additional sounds not attributed to the phonetic inventory that the child can produce in a supportive condition, most typically in response to an auditory model (Glaspey & Stoel-Gammon, 2005; Lof, 1996; Powell & Miccio, 1996).

In the current study, stimulability to speech sound was tested using the prompt levels given in Table 11. The compilation of picture developed for assessing stimulability to speech sounds were utilized in this evaluation along with selective words during the interactive play sessions.

Table 8

Prompt levels used for stimulability assessment

Level	Type of support	Example: Target sound /ba/
1	Prompted production without model.	The SLP points to the picture card of a ball and prompts, “What is this?” or /id̪u jeːnu/.
2	Delayed imitation without additional supports.	The SLP waits 3 s after the client’s production and then prompts, “What is this?” or /id̪u jeːnu/.
3	Direct imitation without tactile, visual, or verbal prompts.	The SLP says /baːlu/, waits 3 seconds for the client to repeat.
4	Direct imitation with verbal prompt related to articulatory placement, acoustic goals, or prosodic features.	The SLP directs, “close your lips at the beginning” before the model.
5	Direct imitation with visual support related to articulatory placement, acoustic goals, or prosodic features.	The SLP points to her own lip closure for /ba/.

Table 8 (continued)

6	Direct imitation with tactile support related to articulatory placement, acoustic goals, or prosodic features.	The SLP manipulates the client's jaw position as he produces /ba/ in /baːlu/.
7	Simultaneous production with tactile support Simultaneous production without additional support.	The SLP and the client say /baːlu/ at the same time, with tactile support if needed.

Note. Adapted from the prompting hierarchy used in the ACT4CAS therapy approach (Beiting & Maas, 2021). Please refer to Table 3.

The list of sounds to which each of the participant is stimulable is given in Table 9.

Table 9

Pre-therapy stimulable speech sounds for each participant

Participant	Stimulable sounds	Prompt level at while the participant is stimulable to the sound.
P1	/p/, /b/	Level 7- for both the sounds
P2	/p/	Level 7
P3	Nil	Nil

The format used to collect child’s case history and evaluation details and samples of picture stimuli used for assessment have been provided in Appendix A.

ACT4CAS Intervention

The intervention was carried out in three steps. Step 1 involved selection of target words, step 2 involved development of video models, step 3 involved implementation of therapy approach with modifications required.

Step 1: Selection of target words

Treatment targets were individually designed for each participant. Target words for the therapy were chosen by discussing with the parents on the basis of following aspects:

a. Functional use of the word/ highly rewarding

Words that have greater functional utility and/or words that are highly rewarding were given priority while choosing words to be targeted.

b. Frequency of the word used in everyday communication

Words that are used frequently in the child's everyday life situation were given priority while choosing words to be targeted.

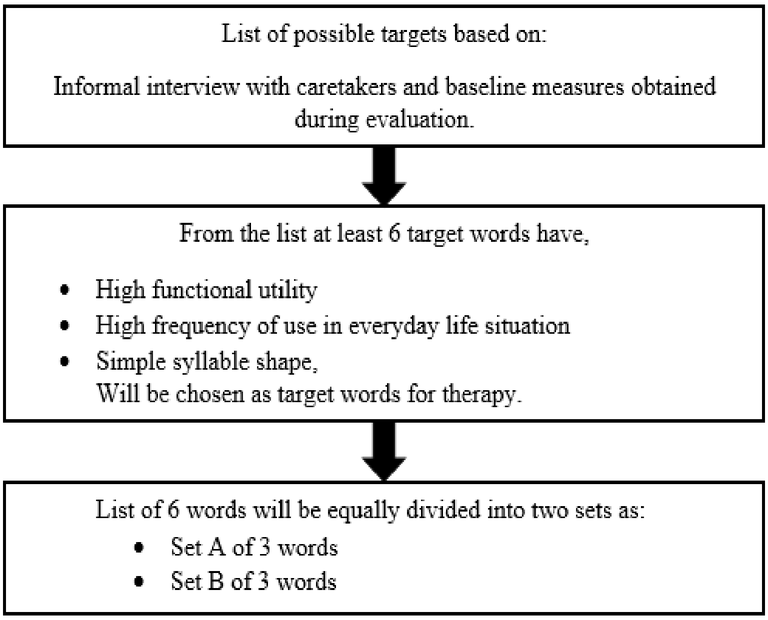
c. Syllable shape

Based on the above two conditions, the possible target words for therapy were listed. Based on this list, potential targets were narrowed according to the child's assessment performance and clinical judgment. Words with lesser complexity or simple syllable shapes such as VCV, CV and CVCV were prioritized.

Considering the above conditions, at least six target words were chosen for the upcoming therapy. These target words were randomly divided into two equal set which would be targeted one after the other in the therapy session. For participants P1 and P2, two target words were removed and only four target words were chosen due to their limited attention span and ability to engage in the therapy session.

Figure 2

Overview of target selection process



List of possible targets based on:

Informal interview with caretakers and baseline measures obtained during evaluation.

From the list at least 6 target words have,

- High functional utility
- High frequency of use in everyday life situation
- Simple syllable shape,

Will be chosen as target words for therapy.

List of 6 words will be equally divided into two sets as:

- Set A of 3 words
- Set B of 3 words

Target words were chosen for each of the participant is listed in Table 10.

Table 10

Target words chosen for each participant

Target words of P1			
Set A		**Set B**	
/haːj/	Hello/ greeting	**/pupu/**	Bag
/pɔpɔp/	Bubble	**/pepe/**	Slime-Press
/uʈa/	Food	**/baːj/**	Bye/greeting
Target words of P2			
Set A		**Set B**	
/mamam/	Food	**/aːbu/**	Water
/pɔpɔp/	Bubble	**/buʃ/**	Wash
Target words of P3			
Set A		**Set B**	
/mamam/	Food	**/haːj/**	Hello/greeting
/pɔpɔp/	Bubble	**/baːj/**	Bye/greeting

Step 2: Development of pre-recorded video models and play materials.

Development of pre-recorded video models: Once these target words were selected, pre-recorded videos for drill-based practice in the therapy sessions were developed. Pre-recorded videos served as visual aids for ACT4CAS approach that aims to demonstrate visible articulation without placing an emphasis on the necessity of direct eye contact with the clinician/researcher for clients. The visual aids such as images and video clips that visually depict the meaning conveyed in the target expression (i.e., emphasizing on meaning) were developed and compiled to align with the specific words targeted for each individual child.

The development of pre-recorded videos followed three steps as described below:

1. Preparation of script
2. Video recording
3. Compilation of video clips according to target word into different folders

Preparation of Script: The script included simple phrases or sentences that are commonly used in everyday conversation or play activities, incorporating the target word in a functional manner. The script for few of the target words are as follows:

Target: /mamam/

/nange mamam beːku/ (I want /mamam/)

/nange mamam kʰardʒura beːku/ (I want /mamam/ dates)

Target: /pɔpɔp/

/nanu pɔpɔp babal madt̪ini/ (I will blow /pɔpɔp/ bubbles)

/nan hat̪ra pink kalar pɔpɔp babals ide/ (I have pink color /pɔpɔp/ bubbles)

Target: /pupu/

/pupu bag alli aːlmaɳɖs id̪e/ (/pupu/ bag has animal models)

/pupu bag alli braʃ id̪e/ (/pupu/ bag has brush)

Video recording: The recording process was carried out in a quiet and well lit room enhanced by context-specific props (such as a bag with animal models while filming the video for the target phrase ‘There are animals in the bag’). Each recording was limited to 30 seconds, to enable the presentation of multiple videos within a concise 10-minute timeframe during drill-based practice (see treatment procedure).

Compilation of video clips according to target word into different folders: Pre- recorded videos were organized and grouped into distinct folders corresponding to the target word they are intended for. This was done to ensure quick and easy access of the videos during the drill-based practice in the therapy sessions. The video models for each of the target words chosen for all participants have been transcribed in Appendix B.

Play materials for play based practice in the therapy sessions: The play materials selected for use in the play-based practice during therapy sessions were tailored to each child, taking into account the target words. These materials were chosen to enable functional and/or playful incorporation of the target word. As an example, to evoke the target word 'open' (/oːpan/ in Kannada), play materials such as a box of toys, box of picture cards were employed. This aimed to facilitate the elicitation of the target word in functional contexts, such as ‘opening the box/bag to get toys. The rest of the activities used in the sessions are listed in the Appendix B.

Step 3: Implementation of therapy approach

Following the selection of target words and compilation of video models, the ACT4CAS therapy approach was implemented. The intervention in this study consisted of a total of 15 sessions, including a mid-baseline assessment. Initially, 7 intervention sessions were conducted, followed by a mid-baseline assessment session.

Subsequently, the ACT4CAS intervention resumed for an additional 7 sessions.

Treatment Procedure: The treatment procedure has been adjusted in accordance with the current objectives of the study, drawing from the method advocated by Beiting and Maas (2021) as delineated in the ACT4CAS proposal.

ACT4CAS intervention was carried out by the researcher. Participants P1 and P3 received all treatment procedures in a dedicated room at the All India Institute of Speech and Hearing, Mysuru, while participant P2 received all sessions at participant's home. Throughout all sessions, at least one parent/caregiver was present.

Each treatment session lasted for 50–60 minutes. The sessions commenced with a review of the visual schedule and the selection of reinforcers, which would take approximately 10 minutes. The first set of target words would then undergo a 10-minute blocked, drill-based practice, followed by a 10-minute play-based practice. After a break of no more than 10 minutes, the same procedure will be followed for the second set of target words.

The drill-based practice took place with the seating arrangement at a table or on the floor. During this phase, pre-recorded video models developed for the target words were displayed on a laptop. Adjustments to the loudness and speed of the videos were made within the session as required. Each practice set consisted of two to four video models, interspersed with static pictures and video clips. If required, video rhymes were added in-between to reinforce the participant. Following the viewing of the sequence, the child was prompted to verbally repeat the target word. The researcher shaped accurate productions using a prompt hierarchy (see Table 11). Social praise and brief exposure to preferred reinforcers, selection of reinforcing toys or event as target word were employed to motivate efforts and sustain attention.

Table 11

Autism-Centered Therapy for Childhood Apraxia of Speech prompt hierarchy

Level	Type of support	Example
1	Simultaneous production with tactile support Simultaneous production without additional support.	The SLP and the client say /amma/ at the same time, with tactile support if needed.
2	Direct imitation with tactile support related to articulatory placement, acoustic goals, or prosodic features.	The SLP manipulates the client's jaw position as he produces /a/ in /amma/.
3	Direct imitation with visual support related to articulatory placement, acoustic goals, or prosodic features.	The SLP points to her own lip closure for /amma/.
4	Direct imitation with verbal prompt related to articulatory placement, acoustic goals, or prosodic features	The SLP directs, “close your lips at the beginning” before the model.
5	Direct imitation without tactile, visual, or verbal prompts	The SLP says /amma/, the client repeats.
6	Delayed imitation without additional supports	The SLP waits 3 s after the client’s production and then prompts, “say it again.”
7	Prompted production without model	The SLP points to the client’s mom and prompts, “Who is that?” or /id̪u ja:rU/.

Note. Retrieved from Beiting M, Maas E. Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS): A Single-Case Experimental Design Study. Am J Speech Lang Pathol. 2021 Jun 18;30(3S):1525-1541. doi: 10.1044/2020_AJSLP-20-00131. Epub 2021 Mar 8.

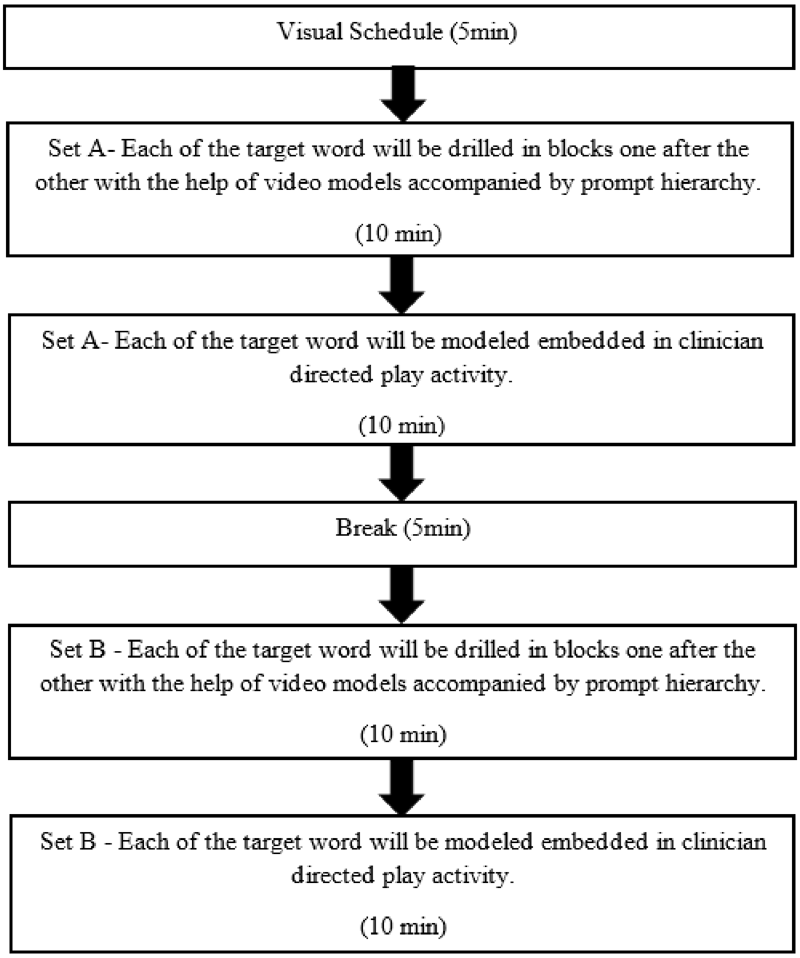
PMID: 33684309.

The play-based practice was implemented with participants either seated on the floor or at a table, or with the option for free movement within the therapy room. Play materials developed for play based practice in the therapy sessions were utilized for the therapy sessions. It consisted of three to five activities strategically designed to evoke the target words, offering numerous opportunities for practice. Sample activities for the target word open (/oːpan/ in Kannada language) could include (a) opening the box to find the gifts, (b) opening a toy lunch box to pretend eating food or snacks, and (c) opening the door of toy house to find the puppet to play with. The child was be provided with options among different activities and had the freedom to transition to new activities as they wish. Initially the clinician/researcher would lead the activity; the caregiver would be encouraged to observe or join and lead the activity. The adults would model the target using the prompt hierarchy with moderate direct requests for imitation. Language facilitation techniques like (a) following the child's lead, (b) modeling without expecting repetition, (c) reinforcing all attempts, and (d) repeating the child's productions would be employed (Beiting & Maas, 2021). After practicing the first set of targets, the child was offered a short (≤ 10 min), unstructured break. After the break, the second target was practiced using the same procedure.

The overview of treatment procedure has been depicted in the Figure 3

Figure 3

Overview of treatment procedure



Post-therapy Baseline Evaluation

After completing the treatment procedure, a post-therapy baseline evaluation was conducted. This evaluation included clinician-directed interactive play sessions over three sessions across one week, using play activities for language sampling and picture stimuli to assess responsiveness to speech sounds. These activities mirrored those used in the pre-therapy baseline assessment, with the addition of functional play to probe the target words addressed during the ACT4CAS therapy intervention for each participant. Post-therapy measurements were collected for dependent variables based on these sessions.

Data Analysis

The data analysis included analysis of both baseline evaluation sessions and therapy sessions. It was carried out as follows:

Analysis of Baseline Evaluations (Pre-mid-post therapy comparison):

Primary measure: It involved comparing the following dependent variables between pre-therapy, mid-therapy and post-therapy evaluations:

1. Verbal expressive repertoire.
2. Social communication and language measures.
3. Consonant inventory.
4. Vowel inventory.
5. Stimulability to speech sound production.

Secondary measure:

Percentage of response elicited in each session: This involves assessing the percentage of responses elicited relative to the number of prompts presented for each of the target word addressed during the intervention, using the following calculation:

$$\boldsymbol{Percentage\ of\ response\ elicited\ in\ a\ therapy\ session} = \frac{\begin{array}{c}\boldsymbol{Number\ of\ reponses}\\ \boldsymbol{elicited\ by\ the\ child}\end{array}}{\begin{array}{c}\boldsymbol{Total\ number\ of\ prompts}\\ \boldsymbol{presented\ in\ the\ therapy\ session}\end{array}}$$

Type of response: The types of responses elicited during each session were recorded, such as whether the response matched the target word accurately, included inappropriate words, approximated the target word, or consisted of gestural responses.

CHAPTER IV

RESULTS AND DISCUSSION

The result of the present study that aimed at investigating the effect of Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) on speech and language skills in minimally verbal children with ASD is described and discussed under the following headings:

Impact of ACT4CAS intervention on the following language parameters:

This involves analysis of baseline evaluations (pre-mid-post therapy baseline comparison) for the following parameters:

1. Verbal expressive repertoire.
2. Social communication and language measures.

Note that, for VER, in addition to analyzing baseline evaluations, the percentage of responses elicited for the target words during each therapy session for each participant was analyzed.

Impact of ACT4CAS intervention on the following speech parameters:

This involves analysis of baseline evaluations (pre-mid-post therapy baseline comparison) for the following parameters:

1. Consonant inventory.
2. Vowel inventory.
3. Stimulability to speech sound production.

Discussions on the findings of research will be carried out at the end of each sub-section of results.

Impact of ACT4CAS intervention on the following language parameters:

The analysis of responses given by the participants during therapy sessions and comparison of measures of dependent variables for the language parameters between pre-, mid- and post-therapy evaluations are as follows:

Verbal expressive repertoire (VER)

Results:

VER of P1: For P1, the words targeted during intervention were / haːj/, /pɔpɔp/ and /uʈa/ in set A and /pupu/, /pepe/ and /bai/ in set B as given in Table 10 (see Method). The percentage responses for the targeted words during the initial 7 sessions and the subsequent 7 sessions of the ACT4CAS intervention, are graphically represented in Figure 4 and 5. These responses along with the VER of P1 across the three baselines are analyzed as follows:

VER of P1 during pre-therapy baseline evaluation: P1 had no words in his VER.

VER of P1 during initial 7 sessions of ACT4CAS: During the sessions 1, 2, 3, 4 and 5 the responses to the target words were minimal. However, it was observed that when prompted during sessions 6 and 7, P1 repeated the word /papa/ with a frequency of 15% and 13% respectively; /pe/ with a frequency of 23% and 10% respectively; and /haːj/ with a frequency of 28% and 30%, respectively. Regardless, he did not have any verbal response for the targets /haːj/, /uʈa/, and /pupu/.

VER of P1 during mid-therapy evaluation: P1 was able to use the words /papa/ and /pepe/ to refer to his play toy bubbles and slime, respectively, with a frequency of 10%. He used the word /baːj/ to say goodbye with a frequency of 20%. He did not have any verbal response for the targets /haːj/, /uta/, and /pupu/.

VER of P1 during later 7 sessions of ACT4CAS: No uniform increase in the responses elicited were observed, however as compared to the first half of the intervention, the frequency of response elicited had increased as seen in session 12 and 13. During session 12 and 13, when prompted he was able to repeat the word /papa/

at a frequency of 26% and 40% respectively; /pe/ at 17% and 30% respectively; and /bai/ at 23% and 50%. He did not have any verbal response for the targets /haːj/, /uʈa/, and /pupu/, but when prompted, he responded with mouth opening posture and hand wave gesture for /haːj/ 10%-20% of the time across the sessions and responded with lip rounding for /uʈa/ 10-30% of the time.

VER of P1 during post-therapy baseline evaluation: P1 consistently used the words /papa/ and /pe/ with a frequency of 50% to refer to his play toy bubbles and slime. And used / baːj/ with a frequency of 50%-60% to greet goodbye. However, for /uʈa/ he responded with lip rounding posture at a frequency of 10%-20% and for /haːj/, he responded with open mouth posture and hand wave gesture at range of 10%-20% each. He was not able to vocalize any of the later target words. Aside from the words targeted during the intervention, there was no spontaneous addition of new words into his VER. Thus, VER of P1 included three words and/or syllables: /baːj/, /papa/, and /pe/ as these met the 50% and above criteria.

Figure 4

Graphical representation of responses to target words taken in Set A for P1

Set A

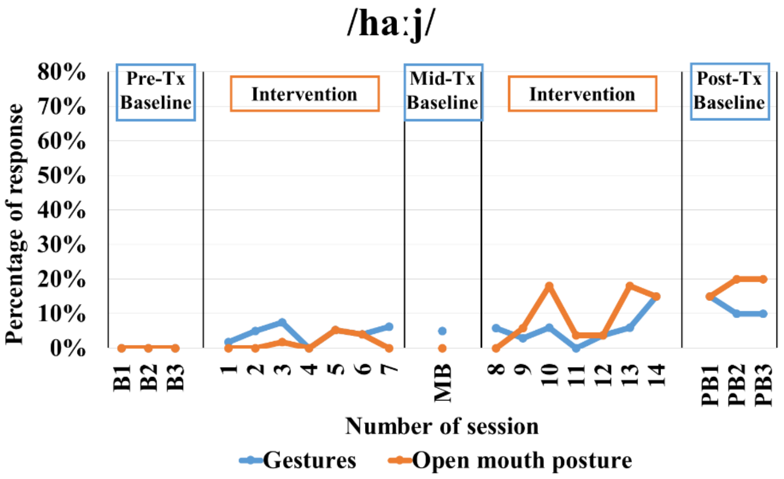
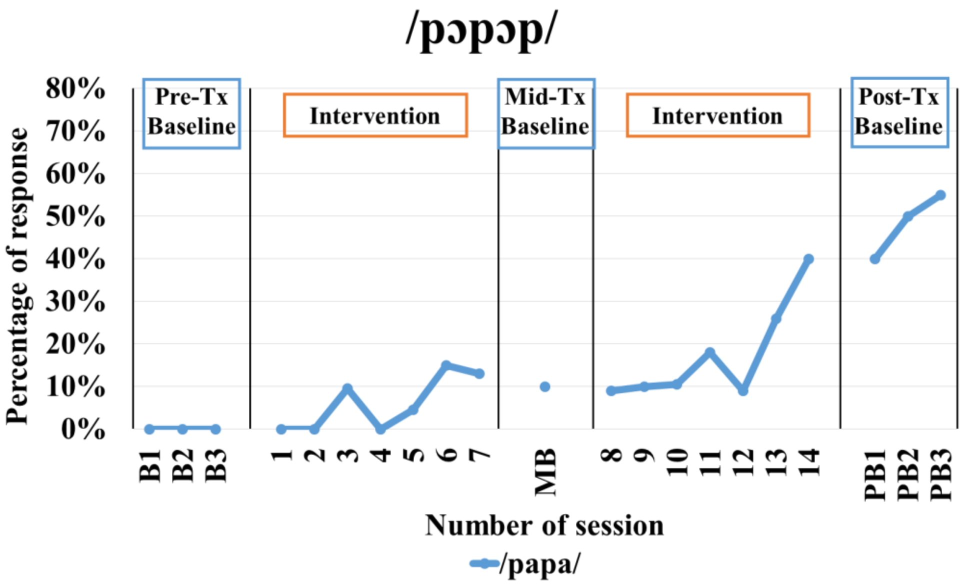


Figure 4 (Continued)

Graphical representation of responses to target words taken in Set A for P1

Set A



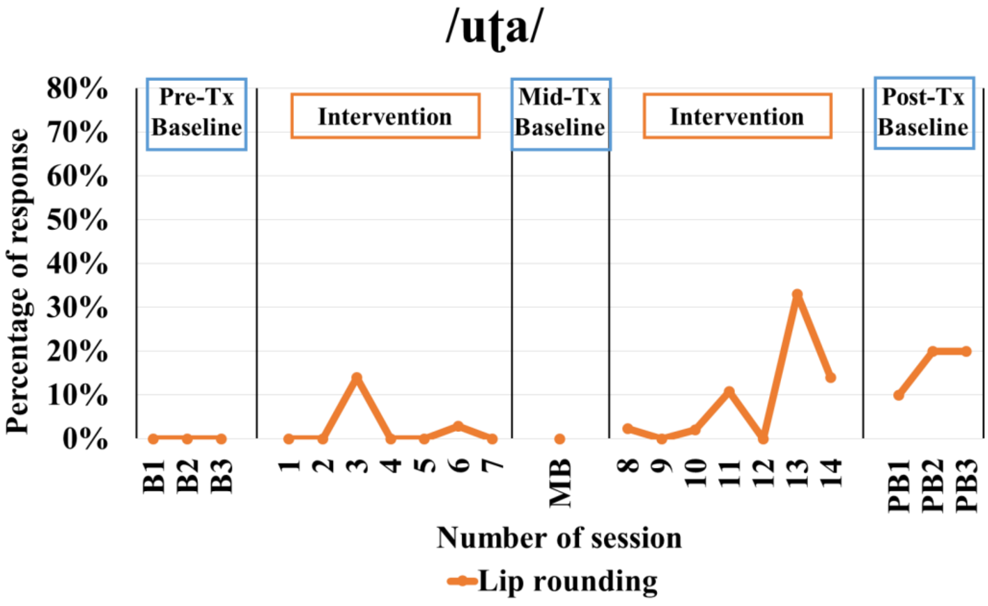
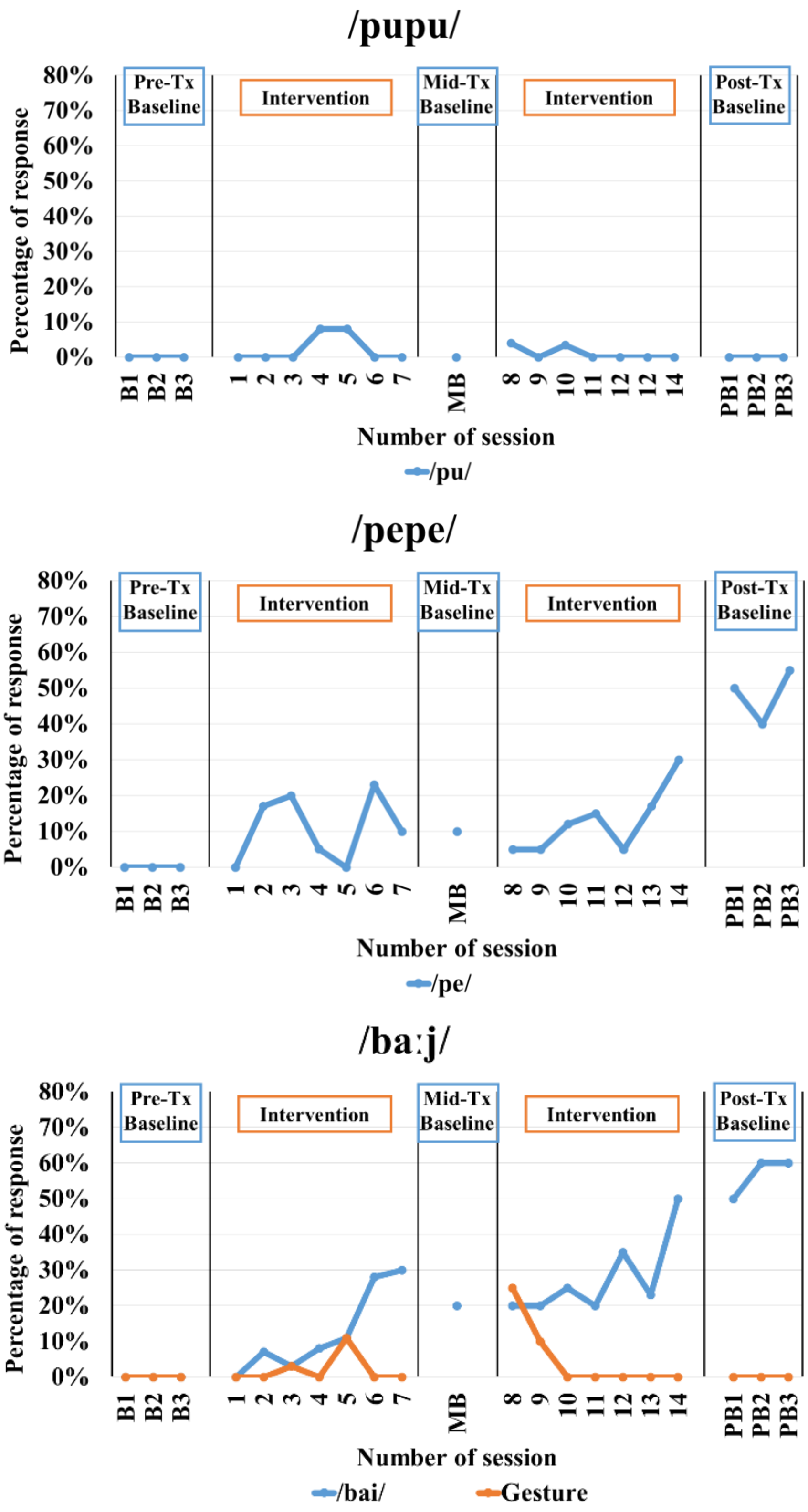


Figure 5

Graphical representation of responses to target words taken in Set B for P1

Set B



VER of P2: For P2, the words targeted during intervention were / mamam/ and /pɔpɔp/ in set A and /abu/ and /buʃ/ in set B as given in Table 10 (see Method). The percentage responses for the targeted words during the initial 7 sessions and the subsequent 7 sessions of the ACT4CAS intervention, are graphically represented in Figure 6 and 7. These responses along with the VER of P2 across the three baselines are analyzed as follows:

VER of P2 during pre-therapy baseline evaluation: P2 had no words in his VER.

VER of P2 during initial 7 sessions of ACT4CAS: In sessions 1, 2, and 3, P2's responses to the target words were nil. However, across sessions 4 to 7, when prompted, he repeated the word /mamam/ with a frequency range of 10%-20%. Additionally, he responded to 10%-20% of the prompts by making lip movements that mimicked the production of the target word /mamam/. This response of mimicking the lip movement was also observed for the target words, /pɔpɔp/ at a frequency of 5%-10%, /abu/ at 10%-20%, and /bu/ (for the target /buʃ/) at 10%-15%. Whereas, verbal responses for all these targets remained nil.

VER of P2 during mid-therapy evaluation: P2 was able to use the word /mamam/ to refer to snacks or food with a frequency of 20%. When prompted, P2 also mimicked lip movements for the target words /mamam/ at a frequency of 10%, /pɔpɔp/ at 5%, and /bu/ at 10%, while there was no response for the target word /abu/.

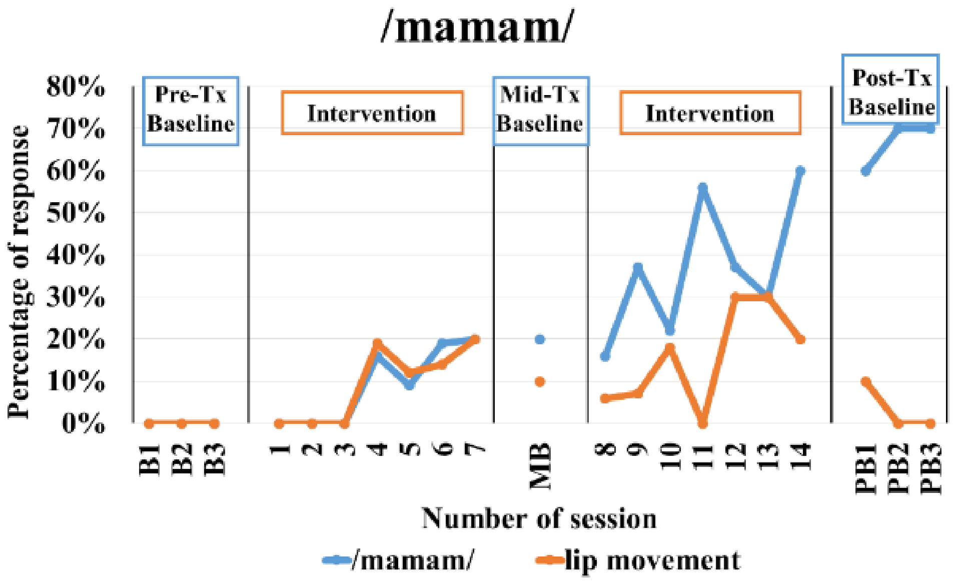
VER of P2 during later 7 sessions of ACT4CAS: During these sessions there was an increase in the frequency of responses for the target words /mamam/, /pɔpɔp/ and /bu/. In the sessions 8, 9 and 10, P2 was able to respond to prompts provided for the target word /mamam/ and /bu/ at a frequency range of 15%-37% and 15%-20% respectively. During sessions 11 to 14, the frequency of responses increased. He responded 30%-60% of the time for /mamam/ and 20%-40% of the time for /bu/ when prompted for the respective words. Whereas, from session 8 to 14, the responses for the words /pɔpɔp/ and /abu/ varied in the frequency range of 5%-30% and 5%-15% respectively. It can be noted that along with these verbal responses, P2 mimicked lip movements for the target words /mamam/ at a frequency range of 10%-30%, /pɔpɔp/ at 10%-25%, /abu/ at 15%-20% and /bu/ at 2%-20%. As the child was able to use the word /mamam/ with a frequency of 50%-60% towards the latter end of this stage, it can be considered as part of his VER at this stage.

VER of P2 during post-therapy baseline evaluation*:* P2 consistently used the words /mamam/ and /bu/. He used /mamam/ to refer to snacks and /bu/ to refer to ‘playing with water’ at a frequency range of 60%-70% and 50% to 60% respectively. It can also be observed that, mimicking the lip movement for /mamam/ reduced to below 10%. Whereas, mimicking lip movements for the targets /pɔpɔp/, /abu/ and /bu/ remained at a frequency range of 15%-25%, - 0%-20% and 0%-10% respectively. Even for P2, besides the words targeted during the intervention, there was no spontaneous addition of new words into his VER. Thus, P2's VER included two words and/or syllables: /mamam/ and /bu/.

Figure 6

Graphical representation of responses to target words taken in Set A for P2

Set A



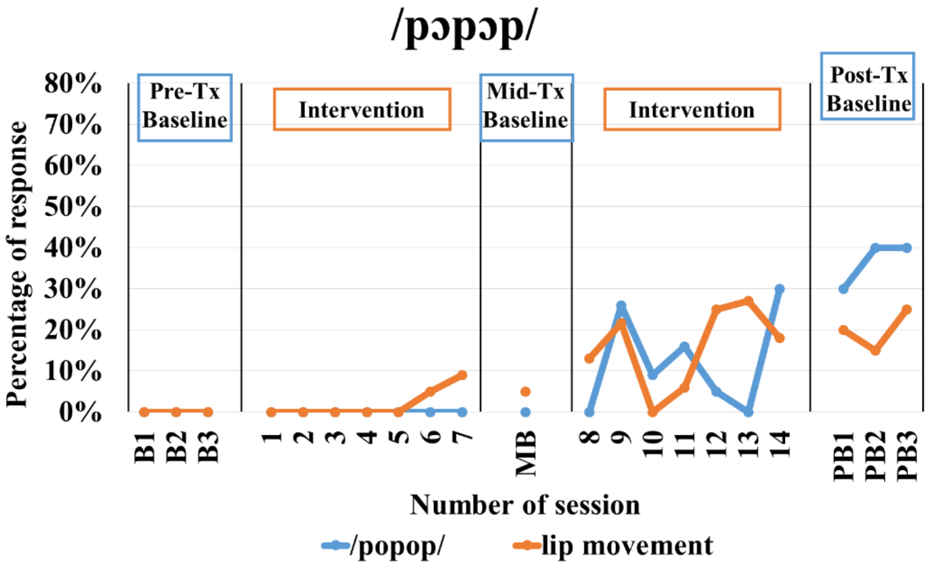
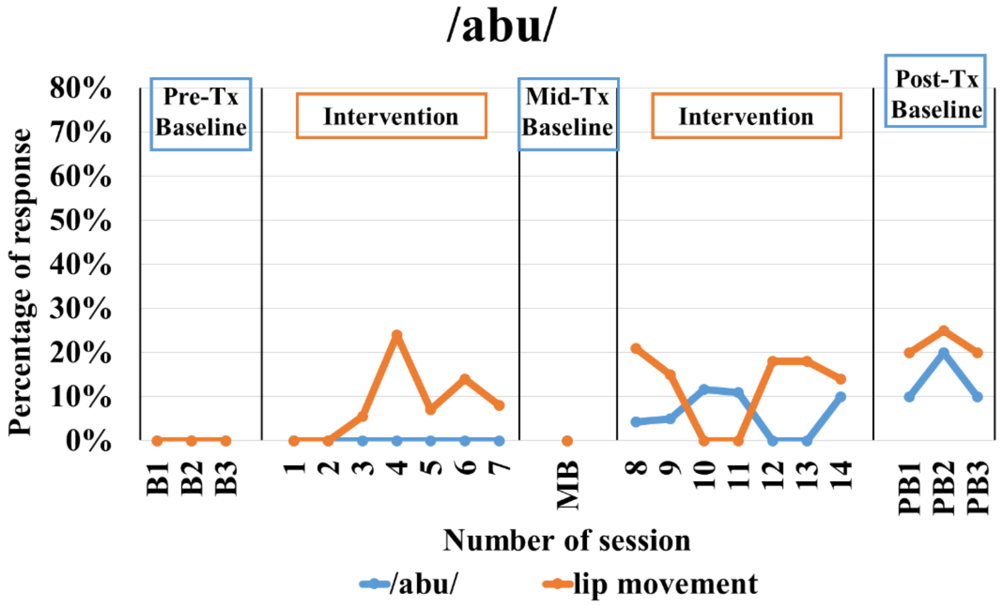
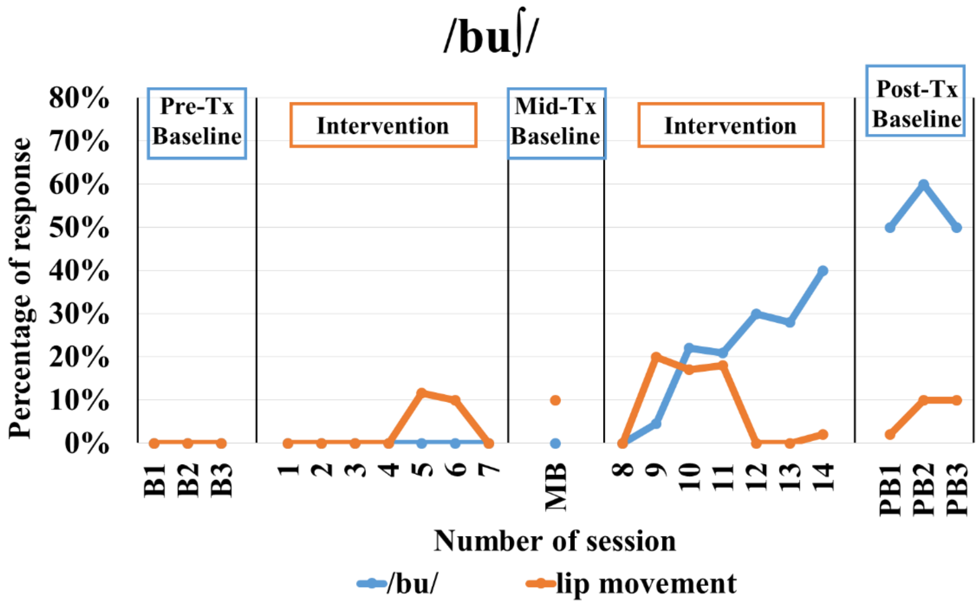


Figure 7

Graphical representation of responses to target words taken in Set B for P2

Set B





VER of P3: For P3, the words targeted during intervention were /mamam/ and /pɔpɔp/ in set A, /haːj/ and /baːj/ in set B as given in Table 10 (see Method). The percentage responses for the targeted words during the initial 7 sessions and the subsequent 7 sessions of the ACT4CAS intervention, are graphically represented in Figure 8 and 9. These responses along with the VER of P3 across the three baselines are analyzed as follows:

VER of P3 during pre-therapy baseline evaluation: P3 had no words in his VER.

VER of P3 during initial 7 sessions of ACT4CAS: Verbal response for all the target words were nil. However, when prompted for the targets /mamam/ and /pɔpɔp/, P3 was able to mimic the lip movement and produce of the target sounds in the initial position of the word that is /m/ and /p/ at a frequency of less than 15%.

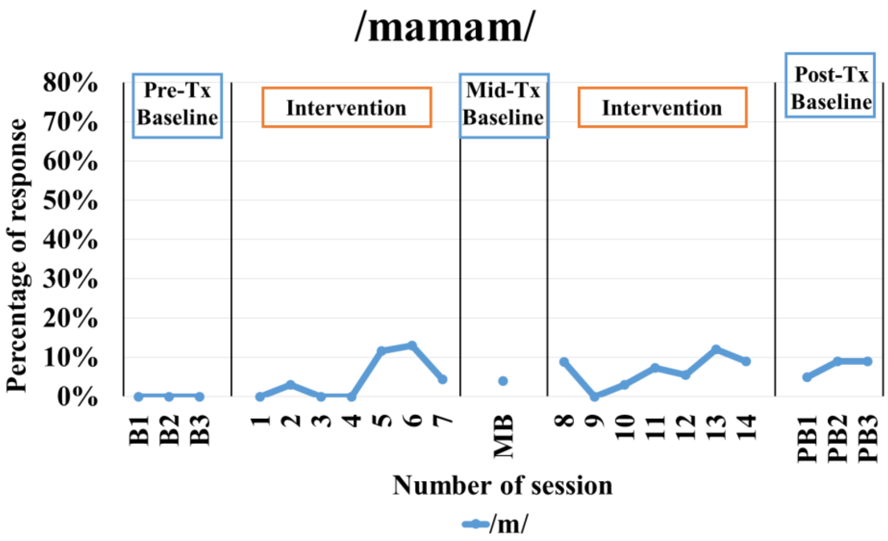
VER of P3 during mid-therapy evaluation: VER of P1 remained nil. Also, there were no response to the target words that were prompted, except for the /mamam/ where P3 was able to produce /m/ as response to prompts at a frequency of 5%.

VER of P3 during later 7 sessions of ACT4CAS and post-therapy baseline evaluation: VER continued to be nil in this stage as well. However, when prompted for the targets /mamam/, /pɔpɔp/ and /baːj/, P3 was able to mimic the lip movement and produce the target sounds in the initial position of the word that is /m/, /p/ and /b/ at a frequency of less than 15%. It can be noted that these values are consistent with the initial 7 sessions for the targets /mamam/ and /pɔpɔp/ but are new for the target /baːj/. Thus, VER of P3 was nil even after ACT4CAS intervention of 14 sessions.

Figure 8

Graphical representation of responses to target words taken in Set A for P3

Set A



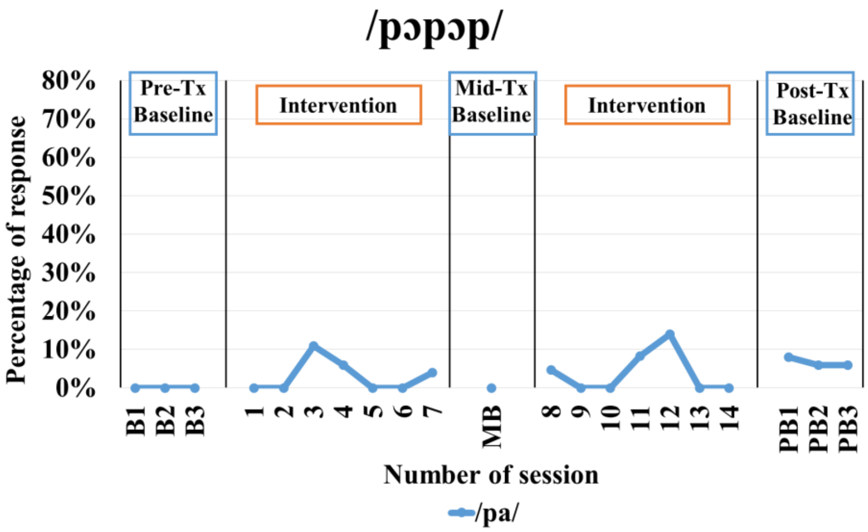
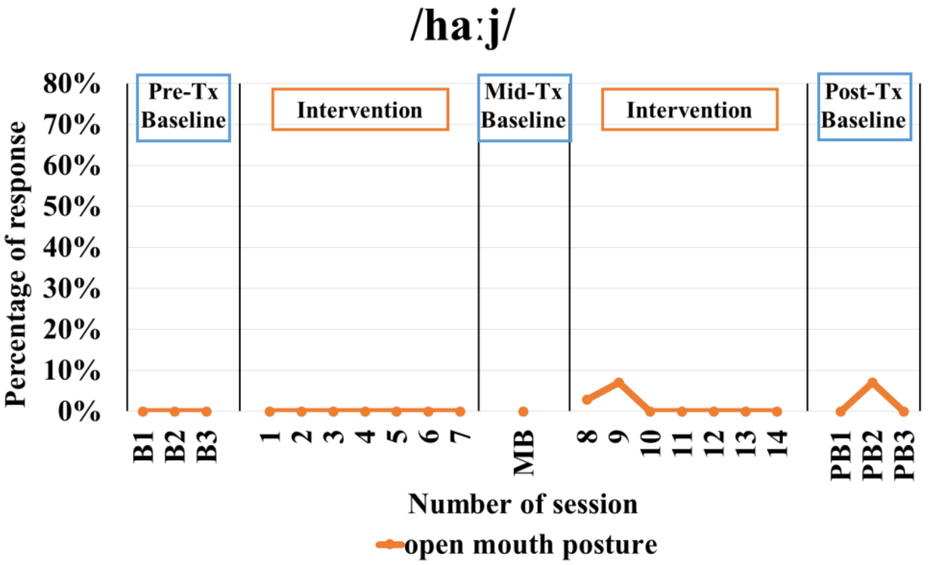
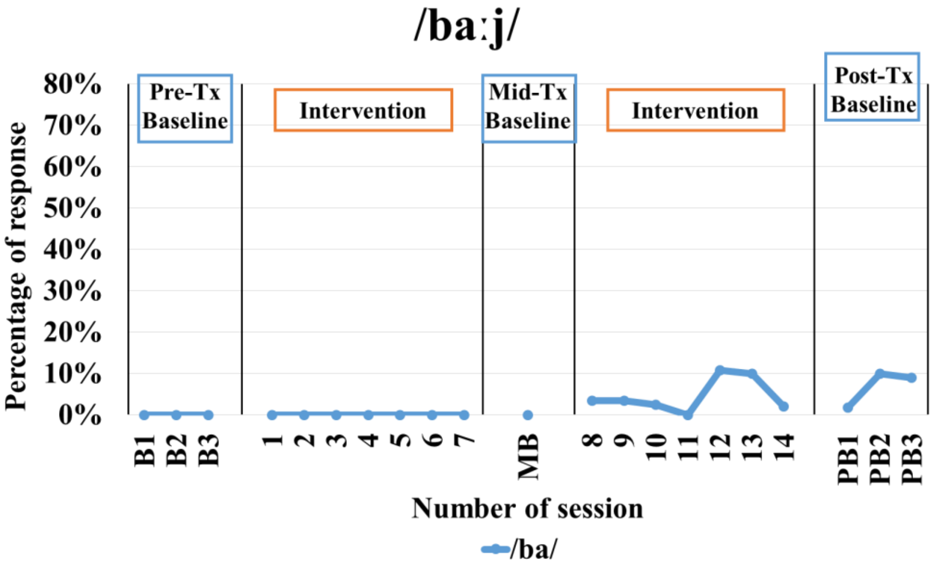


Figure 9

Graphical representation of responses to target words taken in Set B for P3

Set B





Discussion:

Prior to the ACT4CAS intervention, the three pre-therapy baseline evaluations revealed that all participants had no words in their VER, indicating that none of them used any words functionally. This lack of functional use of verbal output persisted through the mid-therapy evaluation for all participants. However, after the intervention of 14 sessions, P1 had three words, namely /baːj/, /papa/, and /pe/ which constitutes the word shapes CV and CVCV, while P2 had two words, namely /mamam/ and /bu/ which constitutes the word shape CVCVC and CV in their VER. In contrast, P3 did not acquire any functional words, and his VER remained the same as before therapy. The VER for each participant across all three evaluations is presented in Table 12.

Table 12

Verbal expressive repertoire of participants across three baselines.

Participant	Time-line	Verbal expressive repertoire (VER) and other utterances	Syllable shape of the respective words (SS)
P1	Pre-Therapy	None	-
	Mid- Therapy	None	-
	Post- Therapy	/baːj/, /papa/, /pe/	CV, CVCV
P2	Pre-Therapy	None	-
	Mid- Therapy	None	-
	Post- Therapy	/mamam/, /bu/	CVCVC, CV
P3	Pre-Therapy	None	-
	Mid- Therapy	None	-
	Post- Therapy	None	-

Since two out of the three participants showed improvement in their VER, the ACT4CAS program demonstrated a positive impact on the VER of minimally verbal children with ASD in this study. Although the children were able to acquire and use these words functionally to communicate their needs or interests, the frequency with which they used them during sessions varied. During the post-therapy baseline assessments, P1 used /baːj/ (bye) most consistently for greeting. The words /papa/ (for blowing bubbles) and /pe/ (for requesting slime) were used less frequently. P1 used these two words typically only when he really wanted the toy, rather than when prompted or encouraged to repeat them.

On the other hand, P2 was able to use the target word /mamam/ (for snacks/food) most consistently, at a comparatively high frequency to request his activity of interest (playing with water or going for a shower). He also used the word /pɔpɔp/ (blowing the bubbles). Hence, P2 primarily used the latter two words when he was highly interested in obtaining the target toy or activity, and thus, these words specifically /pɔpɔp/, were not elicited frequently during sessions. Additionally, although P2 produced /bu/ functionally, repeating the target word /buʃ/ was found to be more effective with a level 5, 6 or 7 prompt during the sessions. The child had difficulty producing the sound /ʃ/ and instead made a non-verbal fricative-like sound after /bu/.

During acquisition of these target words, P1 and P2 exhibited certain errors such as inaccurate production of vowels in the target word, simplification of the target word and inaccurate production or substitution of consonants in the target words. Although quantitative analysis of type of these errors and frequency of these errors is beyond the scope of this study, observations on these errors have been described.

Inaccurate production of vowels: It was observed that P1 had difficulty in accurately producing the word /baːj/, specifically he made errors with the diphthong /aːj/. In the initial sessions he said /ba/ or /bi/ or produced an inaccurate /aːj/. Similarly, he had difficulty producing the /ɔ/ sound in /pɔpɔp/, often substituting it with /a/. In the latter half of the intervention, he was able to produce the word /baːj/ correctly with minimal distortions in the diphthong /aːj/. But he continued to struggle with the /ɔ/ sound and consistently said /papa/ instead of /pɔpɔp/. These inaccurate productions of vowels were also observed in P2, since he had difficulty accurately producing the /o/ sound in /pɔpɔp/ and inconsistently substituting it with between /ɔ/ and /a/ sounds. Therefore, it is evident that P1 and P2 experienced difficulty in accurate production of vowels, which suggests the presence of oral motor impairment. Ziethe et al. (2007) found that inaccurate production of monophthongs and diphthongs is a major indicator of CAS and can aid in distinguishing CAS from phonological impairments. Their study identified that evaluations of vowel errors through perceptual and acoustical evaluations in children suspected of having CAS, can be a major diagnostic tool for identifying CAS. Consequently, the incorrect production of monophthongs and diphthongs in P1 and P2 points towards the presence of CAS, however this can only be confirmed by following up the types of speech sound errors the child would exhibit with increase in their expressive repertoire.

Simplification of the target words: Another observation made pertains to the word shapes that P1 and P2 were able to acquire. P1 used the word /papa/ with a CVCV word shape instead of the target word /pɔpɔp/ with a CVCVC word shape. Similarly, instead of acquiring the target word /pepe/, he simplified the CVCV word shape to CV by using the word /pe/. These observations were made for P2 as well as where, he simplified the target word /buʃ/ of word shape C1VC2 to /bu/ of word shape CV. Also, he had difficulty producing the target /abu/, which has the word shape V1CV2. Even though he could produce the sounds /a/ and /bu/ one after the other when prompted separately, he faced difficulty in sequencing them together to form the target word. As a result, he required Level 6 or Level 7 prompts to produce this word throughout all the sessions of the intervention. These observations indicate that P1 and P2 struggle to produce words with varying consonants, different vowels, and/or polysyllabic structures, which are indicative of CAS (Murray et al., 2015). A study conducted by Canault et al. (2020) on French-speaking children with CAS found that these children most commonly produced words with a CV syllable shape. This was followed by V, VC, and CVC shapes, with polysyllabic words often being simplified to these simpler word shapes, thus concluding that syllable structure simplification may an indicator of CAS. In these participants, regardless of presence of CAS, ACT4CAS can be predicted to give positive results. As ACT4CAS chooses the targets for intervention based on words complexity and also allows for the selection of targets based on the child's consonant repertoire, it ensures that the chosen targets are easily achievable and can be effectively trained.

Inaccurate production or substitution of consonants: It was observed that both P1 and P2 had difficulty in differential production of /p/ and /b/ sounds, and often produced these to sounds interchangeably. Also, although P2 was initially able to produce /p/ sound with prompts provided, during few middle sessions of intervention, P2 produced /m/ sound for the speech cues provided for /p/ or /b/ indicating difficulty in accurate production of speech sounds. Presence of such inconsistent errors in consonant production also are major features of CAS (ASHA, 2007b, p.4.). On similar lines, P2 was not able to produce the sound /ʃ/ in the target /buʃ/ and substituted it with a non-verbal fricative-like sound after /bu/. This difficulty can be attributed to the fact that in children with speech-motor impairment and CAS, early-developing sounds (Shriberg et al., 1997) such as /m,b,j,n,w,d,p,h/ are easily produced and are used at higher frequency as compared to the late-developing sounds such as /ʃ,θ,u,s,z,ð,l,r,a/ which are difficult to acquire and are produced with greater errors as compared to early-developing sounds (Jacks et al., 2006). However, it was observed that after approximately the 10th intervention session, P1 was able to differentially produce /p/ and /b/ sounds, and P2 was able to differentially produce the /m/, /p/, and /b/ sounds in the target words. This indicated that prompt hierarchy used in ACT4CAS was effective in treating the target words/sounds.

Even though all these features mentioned indicates the presence of CAS in P1 and P2, these observations cannot be generalized to conclude the presence of CAS because their expressive vocabulary is very limited and is only emerging. However, this indicates that they might belong to a sub-phenotype of minimally verbal ASD children that have speech motor impairment (Chenausky et al., 2021). Given this fact, implementing ACT4CAS intervention in this group of minimally verbal children with ASD will be effective as it taps on the speech motor deficits in CAS.

In contrast to P1 and P2, for the participant P3, there were no changes in the VER, as he was unable to acquire or functionally use any of the target words post-intervention. This may be due to the fact that P3 had lower IQ and thus was diagnosed with both ASD and BIF (Borderline Intellectual Functioning). Children with both ASD and BIF or intellectual disability have complex communication needs and require more intensive and longer therapy in order to achieve the targets. However, the amount of therapy intensity that is required for this population has not been investigated in literature. This is further supported by research study that reported, among the minimally verbal children with ASD, the response to therapy was greatest among those with higher nonverbal IQ (Mazurek, 2011). Additionally, they also found that, for the children who were non-verbal at the age of 5, IQ and intensity of speech therapy were the most significant factors that predicted the acquisition of speech. Hence, further investigation is required to find if the reduced response to intervention in P3 is due to presence of lower IQ and also to explore the differential effect of ACT4CAS on children with different IQ levels.

Social communication and language measures

Results:

The social communication and language measures considered in the study remained constant for all participants across all baseline evaluation measures. However, as presented in Table 13, there was a subtle change in the expressive language age for participants P1 and P2. Both had an expressive language age of 6-12 months, as measured by the Communication DEALL Developmental Checklists (Com DEALL) (Karanth P, 2007) during the pre-therapy phase. Post-therapy, this age slightly increased to a range of 6-12 months to 12-18 months.

Table 13

Social communication and language measures of participants across three baselines.

Participant	Time-line	Receptive language age (RLA)	Expressive language age (ELA)	Cognitive skills (CS)	Social skills (SS)
P1	Pre-Therapy	Scattered between 18-24 m* to 24-30 m	06-12 m	30-36 m	12-18 m
	Mid-Therapy	NO change	NO change	NO change	NO change
	Post-Therapy	NO change	Scattered between 06-12 m to 12-18 m	NO change	NO change
P2	Pre-Therapy	Scattered between 18-24 m to 24-30 m	06-12 m	30-36 m	Scattered between 12-18 m and 18-24 m
	Mid-Therapy	NO change	NO change	NO change	NO change
	Post-Therapy	NO change	Scattered between 06-12 m to 12-18 m	NO change	NO change

Table 13 (continued)

P3	Pre-Therapy	Scattered between 24-30 m to 30-36 m	06-12 m	30-36 m	18-24 m
	Mid-Therapy	NO change	NO change	NO change	NO change
	Post-Therapy	NO change	NO change	NO change	NO change

Note. *m-months

Discussion:

The increase in ELA from 6-12 months to scattered between 6-18 months in P1 and P2 can be primarily attributed to the improvement in the VER, as these participants were able to verbally request a few things during the post-therapy evaluations. Though the change in their expressive language age is subtle, it represents a significant improvement, marking the transition from the pre-verbal communication phase to the first word phase in expressive language development (Tager-Flusberg et al., 2009). Given this subtle improvement in the verbal expressive repertoire the effect of ACT4CAS on expressive language age can be predicted to be positive with more number of intervention over longer span of time. However, the other parameters such as CS, SS and RLA did not improve with the intervention. This can be reasoned as following:

ACT4CAS is a therapy approach that primarily focuses on verbal expressive abilities of the individual. It does not directly target cognitive or social skills. However, since expressive abilities like narrative skills, morpho-syntax and partially lexicon are direct influencers of social-cognitive skills (Grau-Husarikova et al., 2024), parameters like CS and SS were included in the study. The aim was to see if ACT4CAS can enhance verbal expression and, thus in turn, have an impact on these areas. As the improvement seen in the VER and ELA are subtle the impact of ACT4CAS on these factors cannot be commented in the present study.

Also, the study was conducted for a short span of time. The total time period of the study was 7 weeks that is, two months. Hence, improvement in parameters like cognitive and social skills cannot be expected, as these areas require long-term treatment even when specifically targeted (Bohlander et al., 2012).

Additionally, test materials that can assess these parameters with more specificity such as The Early Social Communication Scale (Mundy et al. 2003/2013) or a similar indigenous test could have been considered instead to the test material administered in the present study (Com DEALL). Com DEALL only provides a broad developmental age for these parameters and does not assess the skills in detail. As a result, any potential subtle changes in these domains due to the intervention cannot be examined.

It is important to evaluate the impact of ACT4CAS on receptive language skills as well in minimally verbal children with ASD as expressive vocabulary size has shown to drive the receptive vocabulary size (Woynaroski et al., 2015). However, as mentioned previously, in the present study, the intervention was provided for a short duration. Along with this, all participants had a significant gap between their RLA and ELA, with RLA being significantly higher than ELA. Given this, the improvements observed in expressive language skills are unlikely to lead to improvements in receptive language skills at this point. It may require further increases in ELA before an observable impact on RLA can be measured.

Therefore, it is necessary to measure the effect of ACT4CAS on these parameters over a longer period of intervention. And also, appropriate test materials mush be chosen such that it can detect subtle variations in the target skills and provide more specific measures on domains like CS, SS and RLA.

Impact of ACT4CAS intervention on speech parameters:

The impact of ACT4CAS on speech parameters such as CI (Consonant inventory) and VI (Vowel Inventory) of the participants were analyzed based on VER evaluations during baseline evaluations and responses of participants to the targeted words during the therapy sessions, as these inventories involve speech sounds that are available to the child for forming words. Whereas stimulability to speech sounds production has been assessed using prompt levels given in Table 11 following the pre-therapy baseline evaluation procedure.

Results:

Consonant inventory

As depicted in the Table 14, during the pre-therapy evaluation, all the three participants had no consonants in their CI even though they were able to produce a few speech sounds during random vocalizations. During the mid-therapy evaluation, the CI of all the participants continued to be nil. However, the post-therapy baseline evaluation revealed that, both P1 and P2 showed an increase in the number of consonants in their CI. P1 had /p/ and /b/ in this CI. This is because now P1 had the words /papa/ and /baːj/ in his VER and also used /pe/ functionally (to indicate his slime toy), which was not a part of VER due to being used at less frequency (40%-50%). P2 had the sounds /m/, /p/, and /b/ in his inventory. This is because now he had the words /mamam/ and /bu/ in his inventory. Additionally, he used the word /pɔpɔp/ functionally (to indicate play of bubble blowing), though its frequency (30%-40%) was not enough to be considered part of his VER. The CI of P3 however, remained nil.

Table 14

Consonant inventory of participants across three baselines.

Participant	Time- Line	Consonant inventory (CI)	Remark
P1	Pre- Therapy	Nil	Production of /p/, /b/ sounds observed during random vocalizations.
	Mid-Therapy	Nil	However was able to produce /p/ and /b/ sounds when prompted at level 5.
	Post-Therapy	/p/, /b/	-
P2	Pre- Therapy	Nil	Production of /p/, /b/, /m/ sounds observed during random vocalizations.
	Mid-Therapy	Nil	However was able to produce /m/ sound when prompted at level 5.
	Post-Therapy	/m/, /p/, /b/	-
P3	Pre- Therapy	Nil	-
	Mid-Therapy	Nil	-
	Post-Therapy	Nil	However, was stimulable for the sounds /p/, /b/.

Vowel inventory

As depicted in the Table 15, the pre-therapy evaluation revealed that, all the three participants had no vowels in their VI. Even though they were able to produce random vocalizations, accurate production of vowels was not observed. During the mid-therapy evaluation, the VI of all the participants continued to be nil. However, the post-therapy baseline evaluation revealed that, both P1 and P2 showed an increase in the number of vowel in their VI. P1 was now able to use target words that included the vowels /a/ and /e/. As he was able to use the words /papa/, /baːj/ and /pe/. While P2 could use target words that included the vowels /a/, /u/ and /ɔ/ as he was able to use the words /mamam/, /bu/ and /pɔpɔp/. Even though VI of P3 remained nil across all the baseline, during post therapy evaluation he demonstrated an increase in overall vocal play or jargon sounds during play activities, primarily consisting of non-specific vowel-like utterances and occasionally including consonants such as /b/, /p/, /m/, and /j/.

Table 15

Vowel inventory of participants across three baselines.

Participant	**Time- Line**	**Vowel inventory (VI)**	**Remark**
P1	Pre- Therapy	Nil	Random vocalizations consists of /a/, /e/, /u/ sounds
	Mid- Therapy	/a/	-
	Post- Therapy	/a/, /e/	-
P2	Pre- Therapy	Nil	Random vocalizations consists of /a/, /i/, /u/, /o/ sounds
	Mid- Therapy	/a/	-
	Post- Therapy	/a/, /u/	-
P3	Pre- Therapy	Nil	Random vocalizations consists of /a/, /i/ sounds
	Mid- Therapy	-	-
	Post- Therapy	-	Random vocalizations consisted of /a/, /i/, /ai/ and /u/ sounds

Stimulability to speech sound production

Stimulability to speech sounds for all the participants across pre-mid-post therapy baseline evaluations have been presented in Table 16, which can be interpreted as follows:

Stimulability to speech sounds in P1: By the end of intervention, P1 was stimulable to speech sounds /p/ and /b/. During the pre-therapy evaluations, P1 was stimulable to the sound /p/ and /b/ sounds at a prompt level of 7. By the mid-therapy evaluation, he was stimulable to these sounds at level 5, and by the post-therapy evaluation, he was stimulable to /p/ at level 2 and /b/ at level 1, requiring minimal assistance in repeating the target word.

Stimulability to speech sounds in P2: By the end of intervention, P2 was stimulable to speech sounds /m/, /p/, /b/ and /o/.

Stimulability to be speech sound /m/: During the pre-therapy evaluation, P2 was not stimulable to the /m/ sound. However, by the mid-therapy evaluation, he was stimulable at prompt level 5, and by the post-therapy evaluation, was stimulable at level 1, requiring minimal assistance in repeating the target sound.

Stimulability to be speech sound /p/: During the pre-therapy evaluation, P2 was stimulable to the /p/ sound at prompt level 7. During mid-therapy evaluation, he was no longer stimulable and regained the stimulability by the post-therapy, as he was then stimulable to /p/ sound at level 5 of prompt.

Stimulability to be speech sound /b/: P2 was not stimulable to /b/ sound at both pre and mid therapy evaluations. However during post-therapy evaluation he was stimulable to /b/ at prompt level 5.

Stimulability to speech sounds in P3: For P3, who did not exhibit improvement in any other dependent variables considered in the study, there was a slight improvement noted in stimulability to speech sounds as by the end of intervention, he was stimulable to speech sounds /p/ and /b/. P3 was not stimulable to these speech sounds during pre and mid therapy evaluations. However during post-therapy evaluation he was stimulable to both the sounds at prompt level 5.

Table 16

Stimulable speech sounds for each participant across three baselines

Participant	Time- Line	Stimulable sounds	Prompt level at while the participant is stimulable to the sound.
P1	Pre- Therapy	/p/, /b/	Level 7
	Mid- Therapy	/p/, /b/	Level 5- for both sounds
	Post- Therapy	/p/, /b/	Level 1- for the sound /b/ Level 2- for the sound /p/
P2	Pre- Therapy	/p/	Level 7
	Mid- Therapy	/m/	Level 5 Note: Stimulability to /p/ reduced mid therapy.
	Post- Therapy	/m/, /p/, /b/	Level 1- for the sound /m/ Level 5- for the sound /p/ Level 5- for the sounds /b/
P3	Pre- Therapy	Nil	Nil
	Mid- Therapy	Nil	Nil
	Post- Therapy	/p/, /b/	Level 5- for both sounds

Discussion:

By the end of intervention, P1 and P2 could acquire 2-3 consonants in their CI, and acquired 2 vowels in their VI. This shows that ACT4CAS can have a positive impact on consonant and vowel inventories of minimally verbal children with ASD. It can be observed that both P1 and P2 acquired easily visible bilabial sounds such as /p/, /m/ and /b/. These are also early developing speech sounds (Morrison & Shriberg, 1992). It has been found that during developmental milestones, the first 10 words that children acquired consists of those words that begin with bilabials (Stoel-Gammon & Cooper, 1984). Which is supported by a study carried out by Fenson et al., (1994) where they found that 22% of words acquired between 9 and 11 months include bilabials. These observations were found to be true in few of the in Indian context languages as, the initial proto words used by typically developing Kannada children were found to be predominantly made up of bilabial sounds (Bharadwaj, Sushma, & Sreedevi, 2015). This indicates that bilabial sounds are predominantly observed in the children when their expressive language age is around 6months to 1$_1$/$_2$ years. Thus, the emergence of these bilabial sounds in our participants correlate with their expressive language age (6months to 18 months) post therapy.

Although P1 and P2 have these newly acquired speech sounds in their repertoire, the effectiveness with which they can use these sounds to form new words is questionable. During the stimulability test, P1 and P2 were tested on producing new words involving the consonants from their newly formed inventory. It was seen that, while they could produce the target sounds, they were unable to form new words. Additionally, while P1 was able to produce the vowel /e/ in the context of the word /pe/, and P2 was able produce the vowel /u/ in the context of word /bu/, they were not able produce these vowels in isolation when modeled or prompted.

The ability to use one’s consonant and vowel inventories to form and learn the production of new words depends on multiple factors, such as the complexity of the new words and child's stimulability to the vowel context in the new word that is being tested. It is also influenced by the individual's proficiency in producing the target speech sound itself, as the presence of a speech sound in one's inventory does not indicate proficiency in producing that sound. This is also supported by the study conducted by Case and Grigos (2016) which found that children with speech motor impairments, need more intensive practice over time to achieve accurate production of novel words and hence struggle to retain newly acquired speech targets and generalize them to untreated contexts. Therefore, the impact of ACT4CAS on speech sound inventory of a child needs to be evaluated over a more intensive and extended period of intervention to accurately determine its effect.

There are other therapy approaches that intervene speech production deficits in minimally verbal children with autism. It majorly in involves AMMT. Research has found that AMMT approach has significant improvement in the speech sound production ability of minimally verbal children with ASD. It has been studied by Wan et al. in 2011 for its effect on non-verbal children with autism. The study carried out by Wan et al. (2011) on impact of AMMT on speech output in the target population, indicated that it resulted in improved CV approximations, increase in number of speech sounds produced and maintenance of targets established. The measure taken was percentage of correctly produced target words, with results revealing an improvement in the measure from 0% in the pre-therapy condition to a wide range of 71% to 8% across 6 children in post-therapy condition. However, comparison between AMMT and ACT4CAS as investigated in the present study cannot be made because of the following reasons:

Although both AMMT and ACT4CAS are designed to intervene speech production aspects. AMMT focuses primarily on the speech production accuracy of the targeted words. Whereas ACT4CAS which taps on the motor speech productions difficulties, has been modified in the present study to focus on both language and speech aspects.

In the study conducted by Wan et al., it was concluded that newly acquired speech sounds can help therapists and parents shape these sounds into words in more practical settings. Therefore, AMMT does not directly target words for functional communication. In contrast, the measures in our present study focus on evaluating the impact of ACT4CAS on language parameters, while also investigating its effects on speech parameters like CI, VI, and stimulability to speech sound production.

AMMT is a high intensity intervention. It is implemented at a frequency of 5days per week where each sessions span for 45 minutes per week. In Wan et al.'s study the total number of sessions provided was 40 sessions that lasted for 8 weeks. Whereas as the present study only had 14 sessions for intervention and 6 sessions for pre and post evaluation spread across 7 weeks. And the therapy outcomes of these two interventions of different intensity, different dependent measures cannot be compared even though both intervene minimally verbal children with ASD.

Thus, given the short duration of intervention implemented, the improvement seen in consonant and vowel inventories of P1 and P2 shows that ACT4CAS has a positive impact on these factors. Similarly, there was improvement in the measure of stimulability to speech sounds. As presented in the Table 16, none of the participants were stimulable to any speech sounds during the pre-therapy baseline evaluation, whereas in during post therapy, P1 was stimulable to /p/ and /b/ sounds, P2 was stimulable to /p/, /b/ and /m/ sounds and P3 was stimulable to /p/ and /b/ sounds. Additionally, it was observed that the level of prompts needed to stimulate sounds decreased for each participant. With the intervention, participants were able to produce the target sounds with less assistance. This indicates that the prompt hierarchy used in ACT4CAS effectively aids in training better speech sound production. Therefore, ACT4CAS was found to have positive impact on stimulability to speech sounds for all three participants in the present study.

In addition to these results, the research study enabled observations on the components of ACT4CAS. It was noted that the use of video models during drill-based practice was effective, as the children had better observation towards the speech sound modeling given through the video models as compared to when given directly. Furthermore, the play-based practice that followed the drill-based practice allowed the child to generalize the newly learned words and sounds in a more naturalistic way. The prompt hierarchy was also found to be effective in establishing new speech sounds in their inventory. However, the visual schedules used to assist the children in transitioning between activities, especially from drill-based to play-based, did not serve their intended purpose. The participants in the present study readily used these visual aids, such as picture cards, to communicate or request their preferred activities. Therefore, these visual schedules were only reviewed at the beginning of the session and were not implemented during the session. Despite this, because the sessions were divided into smaller, manageable parts alternating between drill and play practices, the children readily adjusted to the therapy session design within the initial 3-4 sessions. However, it is challenging to make a broader statement on the efficacy of combining these strategies, as these observations may be specific to individual participants. Further studies in a more controlled setting are needed to determine the overall effectiveness of the therapy when these strategies are combined.

Conclusion:

The study initially considered the following hypotheses:

1. ACT4CAS therapy approach has no impact on verbal expressive repertoire.
2. ACT4CAS therapy approach has no impact on social communication and language measures.

3. ACT4CAS therapy approach has no impact on consonant inventory.
4. ACT4CAS therapy approach has no impact on vowel inventory.
5. ACT4CAS therapy approach has no impact on stimulability to speech sounds.

Based on the results of the present study, all the above hypotheses are rejected, as ACT4CAS was found to have an impact on all the speech and language parameters taken up in the study. However, the extent of this impact needs to be evaluated with further research in a more controlled setting, taking into account factors such as the intensity and duration of the therapy.

During the therapeutic intervention, it was observed that P1 and P2 exhibited speech motor deficits. Consequently, based on the current findings, it can be anticipated that ACT4CAS would have a positive impact on this subgroup of minimally verbal children with ASD who have associated speech motor impairments.

Also, there was differential impact of intervention to the targeted parameters between the participants in the study. The observable reason for this difference was differences in their level of IQ. Difference observed was that, two individuals with normal IQ had improvement in all the domains, while for the one with BIF, ACT4CAS positively impacting only on the parameter of stimulability to speech sounds in the. Therefore, further research is needed to determine whether more therapy sessions are required for ACT4CAS to be effective in this population or if the intervention is only effective for those with average intelligence.

SUMMARY AND CONCLUSION

Among children with ASD, a subset of children remain non-verbal or minimally verbal. Most often, the opted communication strategy for this population is Augmentative Alternative Communication (AAC). Although AAC helps in reducing communication difficulties, reducing the problem behaviors and improving the overall non-verbal expressive abilities, it was found that these do not lead to improvement in the verbal expressive repertoire in the target population (Brignell et al., 2018). Hence, there is need for separate intervention strategies for minimally verbal ASD group that intervenes verbal expressive output in specific. The Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) under discussion in the present research is a novel approach that is specifically designed to intervene speech sound production deficits in children diagnosed with ASD and CAS. However, the approach design has the potential to be modified to target minimally verbal children as well, though no research attempts have been made to do so to date.

Thus, the present study was carried out to find the effect of a novel approach Autism-Centered Therapy for Childhood Apraxia of Speech (ACT4CAS) on speech and language skills in minimally verbal children with autism spectrum disorder. This was done by carrying out a case study approach with pre-post comparison for the speech and language parameters (a) verbal expressive repertoire (b) speech and language measures (c) consonant inventory (d) vowel inventory and (e) stimulability to speech sounds.

Two children diagnosed with ASD (P1 and P2) and one child diagnosed with ASD and BIF (P3), who were minimally verbal with less than 30 words in their verbal expressive repertoire participated in the study. The study was carried out over a span of 7 weeks with 3 sessions per week. It was conducted for 22 sessions that included initial session of parent interview, 3 sessions of pre-therapy baseline evaluation, followed by initial 7 sessions of ACT4CAS intervention, 1 session of mid-therapy baseline evaluation, later 7 sessions of ACT4CAS and final 3 sessions of post-therapy baseline evaluation. Based on the baseline evaluation and parental interview 6 target words were taken for P1 and 4 target words were taken for P2 and P3. ACT4CAS intervention was implemented with modifications required to intervene speech and language aspects in minimally verbal children with ASD.

Post-therapy evaluation revealed that ACT4CAS had a positive impact on parameter of verbal expressive repertoire, consonant inventory, vowel inventory and expressive language age of P1 and P2. Additionally, it had a positive impact on stimulability to speech sounds for all the three participants. This difference in results between P1, P2 and P3 may be because of the differences in the IQ levels, however further investigation through conducting ACT4CAS intervention in this population is required to confirm this. Differential effect of ACT4CAS on children with different IQ levels cannot be commented upon based on the present research evidences.

Given the short duration of the intervention, which consisted of only 14 sessions, the present study observed improvements in speech and language domains, indicating that ACT4CAS had a positive impact on speech and language skills in minimally verbal children with ASD. Further, replication of the study in a more controlled manner is needed to confirm these findings and also the present findings need to be validated on a larger sample size.

Clinical Implications of the study:

- Results of the present study supports that ACT4CAS can be implemented as therapeutic option for speech and language intervention for children in the clinical group who share the same profile as the participant in the present study—minimally verbal children with ASD who have speech motor deficits.

- Can be considered a therapeutic option for minimally verbal children with ASD, particularly when there is a need to focus on speech production aspect.
- This will help in predicting the possibility of speech motor deficits and the need to emphasize on it in the target population.
- It can be implemented by any speech-language therapist without the need for certification or additional training.

Future Direction:

- The results of impact of ACT4CAS on the target population can be further validated on a larger sample size.
- The results of impact of ACT4CAS on the target population can be investigated across different levels of therapy intensity.
- The results of impact of ACT4CAS on the target population can be studied using long-term research
- The differential impact of ACT4CAS on minimally verbal children with ASD and average intelligence can be compared with that on their peers who have lower IQs.

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Appendix A

Assessment questionnaire and samples of picture stimuli used for assessment

Assessment questionnaire

Name:

Age/ Gender:

Education level/ Vocational training of the child:

Education level of the parents:

Any other relevant demographic information:

Age of Onset: Age of intervention:

Type of treatment:

If it led to improvement in Speech and language skills:

If it led to improvement in behavioral skills:

Employment of motorkinesthetic/phonotactic cues during the past therapy and if it helped:

Speech Language and communication skills:

(Will be acquired by parental interview, child-interaction and case file)

1. Uses parent’s hand as a tool for communication:
2. Initiates communication – verbally/non-verbally:
3. Verbal/ non-verbal response to questions asked/ during interation:
4. Uses index finger/hand pointing:
5. Presence of repetition/echolalia (with example):

6. Presence of Imitation Skills- Verbal: Non-verbal:
7. Does the child use gestures, facial expressions, or other non-verbal cues while expressing

Acceptance/ agreeing: Denial: Happy: Angry: Sad:

8. Psychological evaluations done previously
9. Comprehension and expression level of the child

RLA as in diagnostic evaluation done:

ELA as in diagnostic evaluation done:

Detailed description:

	Comprehension	Expression
Commands		
Names		
Questions		
Opposites/adjectives/prepositions/pronouns		
Denials		
Asking for help		
Description		
Non-verbal cues, facial expressions/gestures.		

10. Verbal repertoire of the child:

What are the meaningful words used by the child?

What are the non-meaningful words used by the child?

What are the random vocalizations/ jargon like utterances by child?

Do they use two or three word phrases- if any? Meaningfully or non-meaningfully?

11. Vowel and Consonant repertoire of the child

Can the child utter the following vowels and diphthongs?

(includes both long and short)	Single/sound level during vocalization	At word level (with example/ context)	With imitation (with example/ context)	Distortions/ Substitution errors present if any, consistency of the errors.
/a/				
/i/				
/u/				
/e/				
/o/				
/ai/				
/au/				

Can the child utter the following consonants?

(both aspirated and unaspirated)	Single/sound level during vocalization	At word level (with example/ context)	With imitation (with example/ context)	Distortions/ Substitution errors present if any, consistency of the errors.
/k/				
/g/				
/ng/				
/c/				
/dz/				
/ngy/				
/ṭ/				
/ḍ/				
/ṇ/				
/t/				
/d/				
/n/				
/p/				
/b/				
/m/				
/j/				
/r/				
/l/				

/v/				
/S/ (palato-alveolar)				
/S/ (alveolo-palatal)				
/s/				
/h/				
/l̟/				

Social Interaction:

1. How does the child initiate social interactions/ try to gain attention?
2. Describe the child's ability to make and maintain eye contact.
3. Does the child show interest in interacting with peers?
4. Social smile?
5. How does the child respond to emotions in others (e.g., happy, sad, angry)- emotional reciprocity?
6. Is there evidence of joint attention or shared interests?
7. Autistic withdrawal- better/happy when left alone?

Behavioral skills:

1. Describe any repetitive behaviors or restricted interests observed in the child:
2. How does the child respond to changes in routine or unexpected events?
3. Unusual attachment for inanimate objects?
4. Presence of repetitive sustained odd play:
5. Hyperactivity:
6. Restlessness:
7. Attention span in a single play activity, possible reason for the exhibited behavior:
8. Exhibition of passiveness in an interaction/play:
9. Co-operation for a task:

Sensory Skills:

1. Any sensory sensitivities or aversions as in the case file

Domain	Hyperactivity/ Hypoactivity/self-stimulation	Description
Auditory		
Visual		
Tactile		

2. Does the child engage in self-stimulatory behaviors (e.g., hand-flapping, rocking) or other behaviors?
3. Detailed description:

<u>Visual Sensitivity:</u>

How does the child respond to bright lights or sunlight?

Does the child show aversions or preferences to specific colors or patterns?

Notice any behaviors related to visually stimulating environments?

<u>Auditory Sensitivity:</u>

How does the child react to loud noises or sudden sounds?

Is there a preference for specific types of sounds or music?

Does the child cover their ears in response to certain sounds?

<u>Tactile Sensitivity:</u>

How does the child respond to different textures (e.g., clothing, food textures)?

Is there an aversion or preference for certain tactile stimuli (e.g., hugs, handshakes)?

Does the child seek or avoid physical contact?

<u>Olfactory Sensitivity:</u>

How does the child react to various smells in the environment?

Are there specific scents that the child seems particularly sensitive or indifferent to?

Does the child engage in repetitive smelling behaviors?

Gustatory Sensitivity:

Are there specific tastes or textures of food that the child avoids or seeks out?

How does the child respond to varying temperatures of food and beverages?

Proprioceptive and Vestibular Sensitivity:

Does the child respond to activities that involve pressure or resistance (e.g., hugs, heavy work tasks)?

Describe the child's response to movement or changes in body position.

Does the child seek or avoid activities that involve vestibular input (e.g., swinging, spinning)?

Interoception:

How does the child respond to bodily sensations such as hunger, thirst, or discomfort?

Is there a noticeable difficulty in recognizing internal bodily cues?

Sensory-Seeking or Sensory-Avoidant Behaviors:

Identify any sensory-seeking behaviors observed in the child.

Identify any sensory-avoidant behaviors observed in the child.

Daily Challenges and Coping Strategies:

Describe any challenges the child faces in daily routines related to sensory sensitivities.

Identify any coping strategies or self-regulation techniques the child employs.

Family and Educational Support:

Outline any existing support systems in the family or educational setting to address sensory needs.

Adaptive Skills:

How independent is the child in activities of daily living (e.g., dressing, eating, hygiene)?

Describe any challenges the child faces in adapting to new environments or situations.

Does the child display any self-help skills (e.g., tying shoelaces, using utensils)?

How does the child cope with transitions between activities or environments?

Family and Environmental Considerations:

Information about the child's family dynamics and support system.

Are there any environmental factors that may influence the child's behavior or development?

Additional Comments:

Any other information or observations that you believe would be helpful in understanding the child's needs and abilities?

Play activities the child enjoys:

Objects/ activities that the child is highly distracted by:

Objects/ activities that the child fears about:

Professional Information:

Name of Assessor:

Date of Assessment:

Samples of picture stimuli used for assessment

Picture stimuli for ball

Picture stimuli for bus

Picture stimuli for doll

Picture stimuli for hat

Appendix B

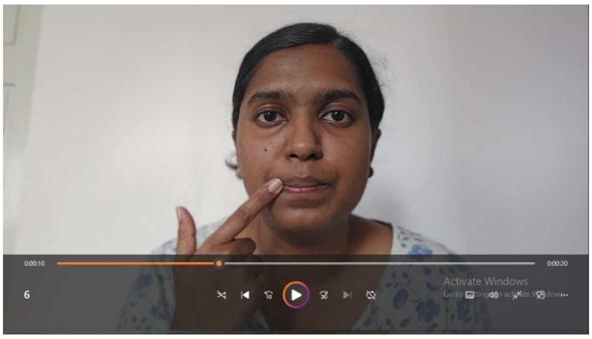
Video models and activities for each of the target words chosen for all of the participants.

Video models for the target word /mamam/

Original sample in Kannada: ನಂಗೆ ಮಮಮ್ ಆಲ್ಮಂಡ್ಸ್ ಬೇಕು. ನಂಗೆ ಮಮಮ್ ತಿನ್ಬೇಕು. ಅಮ್ಮ ನಂಗೆ ಮಮಮ್ ಆಲ್ಮಂಡ್ಸ್ ಕೊಡಿ. ನಂಗೆ ಮಮಮ್ ಆಲ್ಮಂಡ್ಸ್ ಸಿಕ್ತು. ನಾನು ಇವಾಗ ಮಮಮ್ ತಿಂತಿನಿ. ನೆಕ್ಸ್ಟ ಏನ್ ಮಮಮ್ ಮಾಡೋಣ? ನೆಕ್ಸ್ಟ ನಂಗೆ ಮಮಮ್ ಖರ್ಜೂರ ಬೇಕು. ಅಮ್ಮ ಮಮಮ್ ಖರ್ಜೂರ ಕೊಡಿ. ವಾವ್!! ಮಮಮ್ ಖರ್ಜೂರ ಸಿಕ್ತು ಮಮಮ್ ಖರ್ಜೂರ!! ನಾನು ಖರ್ಜೂರ ಮಮಮ್ ಮಾಡ್ತಿನಿ. ನಾನು ಸ್ಕೂಲ್ ಅಲ್ಲಿ ದಿನಾ ಮಧ್ಯಾಹ್ನ ಮಮಮ್ ತಿಂತಿನಿ. ನಾನು ಲಂಚ್ ಬಾಕ್ಸ್ ಅಲ್ಲಿ ಮಮಮ್ ತಗೊಂಡು ಹೋಗ್ತಿನಿ. ನಂಗೆ ಅಮ್ಮ ಲಂಚ್ ಬಾಕ್ಸ್ ಅಲ್ಲಿ ಮಮಮ್ ಕೊಡ್ತಾರೆ. ನಾನು ಮಧ್ಯಾಹ್ನ ಮಮಮ್ ತಿಂತಿನಿ. ನಾನು ಸ್ಕೂಲ್ ಇಂದ ಬಂದ್ಮೇಲೆ ಮಮಮ್ ತಿಂತಿನಿ. ಅಮ್ಮ ನಂಗೆ ಫ್ರುಟ್ಸ್ ಕೊಡ್ತಾರೆ ನಾನು ಫ್ರುಟ್ಸ್ ಮಮಮ್ ಮಾಡ್ತೀನಿ. ನಂಗೆ ಇವತ್ತು ಆರೆಂಜ್ ಬೇಕು. ನಾನು ಇವಾಗ ಆರೆಂಜ್ ಮಮಮ್ ಮಾಡ್ತಿನಿ. ಆರೆಂಜ್ ಮಮಮ್ ಮಾಡ್ದೆ.

IPA Phonemic Transcription: /nange mamam aːlmaɳɖs beːku ‖/ /nange mamam t̪inbeːku ‖/ /amma nange mamam aːlmaɳɖs koɖi ‖/ /nange mamam aːlmaɳɖs sikt̪u ‖/ /naːnu iʋaːga mamam t̪int̪ini ‖/ /nekst̪ eːn mamam maːɖoːɳa ‖/ /nekst̪ nange mamam kʰardʒura beːku ‖/ /amma mamam kʰardʒura koɖi ‖/ /ʋaːʋ |/ /mamam kʰardʒura sikt̪u ‖/ /mamam kʰardʒura ‖/ /naːnu kʰardʒura mamam maːɖt̪ini‖/ /naːnu skuːl allːi d̪inaː mad̪ʱjaːna mamam t̪int̪ini ‖/ /naːnu lantʃ baːks alli mamam t̪agoɳɖu hoːgt̪ini ‖/ /nange amma lantʃ baːks alli mamam koɖt̪aːre ‖/ /naːnu mad̪ʱjaːna mamam t̪int̪ini ‖/ /naːnu skuːl ind̪a band̪meːle mamam t̪int̪ini ‖/ /amma nange fruʈs koɖt̪aːre ‖/ /naːnu fruʈs mamam maːɖt̪iːni ‖/ /nange iʋat̪t̪u ɔ́rendʒ beːku ‖/ /naːnu iʋaːga ɔ́rendʒ mamam maːɖt̪ini ‖/ / ɔ́rendʒ mamam maːɖd̪e ‖/

Translation in English: I want snacks. I want to eat snacks. Mom, please give me almonds for snacks. I got almonds for snacks. I'm eating snacks now. What snacks should we make next? Next, I want dates for snacks. Mom, please give me dates for snacks. Wow!! I got dates for snacks, dates for snacks!! I'm having dates for snacks. I eat snacks every afternoon at school. I take snacks in my lunch box. My mom gives me snacks in my lunch box. I eat snacks in the afternoon. I eat snacks after coming back from school. My mom gives me fruits, and I eat fruits for snacks. Today I want an orange. I am having an orange for snacks now. I had an orange for snacks. (Where snacks is /mamam/).



Play activities planned for the target word /mamam/

The play activities carried out for the target /mamam/ during the play based intervention and mid and post-therapy baseline assessment included eating snacks together, finding what is in the snacks box, serving snacks to each other and to the toys and cooking food.

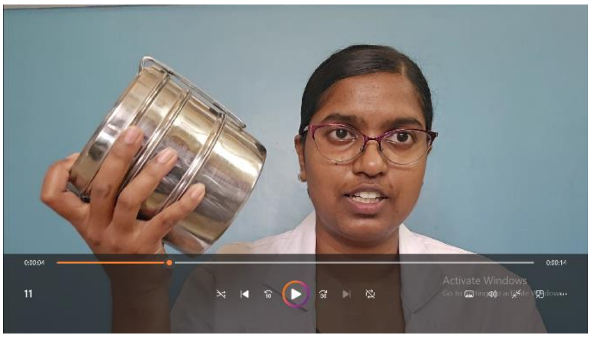
Video models for the target word /uːʈa/

Original sample in Kannada: ನಾನು ನನ್ನ ಬೌಲ್ ಅಲ್ಲಿ ಊಟ ಮಾಡ್ತಿನಿ. ಊಟ ಮಾಡಕ್ಕೆ ಇದು ನನ್ನ ಇಶ್ಟದ ಬೌಲ್. ನಾನು ಹೊಟ್ಟೆ ಹಸಿದಾಗ ಊಟ ಮಾಡ್ತಿನಿ. ಹೊಟ್ಟೆ ಹಸಿದಾಗ ಊಟ ಮಾಡಿದ್ರೆ ಶಕ್ತಿ ಬರುತ್ತೆ. ನಾನು ಬೆಳಿಗ್ಗೆ ಊಟ ಮಾಡಿ ಸ್ಕೂಲಿಗೆ ಹೋಗ್ತಿನಿ. ಸ್ಕೂಲಿಗೆ ನನ್ನ ಅಮ್ಮ ನಂಗೆ ಲಂಚ್ ಬಾಕ್ಸ್ ಅಲ್ಲಿ ಊಟ ಕೊಡ್ತಾರೆ. ಇದು ನನ್ನ ಲಂಚ್ ಬಾಕ್ಸ್. ಒಂದು ಬಾಕ್ಸ್ ಅಲ್ಲಿ ಅನ್ನ ಇನ್ನೊಂದ್ರಲ್ಲಿ ಸಾರು ಕೊಡ್ತಾರೆ. ನಾನು

ಅನ್ನ ಸಾರು ಊಟ ಮಾಡ್ತಿನಿ. ಊಟ ಮಾಡಿ ನನು ಬಾಕ್ಸ್ ಕ್ಲೋಸ್ ಮಾಡ್ತಿನಿ. ರಾತ್ರೆ ನಂಗೆ ಅಮ್ಮ ಊಟ ಕೊಡ್ತರೆ. ನಾನು ಊಟ ಮಾಡಿ ನಿದ್ದೆ ಮಾಡ್ತಿನಿ.

IPA Phonemic Transcription: /naːnu nanna baʋl alli uːʈa maːɖt̪ini ‖/ /uːʈa maːɖakːe id̪u nanːa iʃʈad̪a baʋl ‖/ /naːnu hoʈʈe hasid̪aːga uːʈa maːɖt̪ini ‖/ /hoʈʈe hasid̪aːga uːʈa maːɖid̪re ʃakt̪i barut̪t̪e ‖/ /naːnu beɭigge uːʈa maːɖi skuːlige hoːgt̪ini ‖/ /skuːlige nanna amma nange lantʃ baːks alli uːʈa koɖt̪aːre ‖/ /id̪u nanna lantʃ baːks ‖/ /ond̪u baːks alli anna inːond̪ralli saːru koɖt̪aːre ‖/ /naːnu anna saːru uːʈa maːɖt̪ini ‖/ /uːʈa maːɖi nanu baːks kloːs maːɖt̪ini ‖/ /raːt̪re nange amma uːʈa koɖt̪are ‖/ /naːnu uːʈa maːɖi nid̪d̪e maːɖt̪ini ‖/

Translation in English: I eat food in this blow. This is my favorite bowl to have food. We eat food when we are hungry. Eating when hungry gives energy. In the morning, I eat food and then go to school. My mom packs my food in lunchbox. This is my lunchbox. In one box, she puts rice and in another, she puts curry. I eat food for lunch. After I have food, I close the box. In the evening, my mom gives me food. I eat food and then go to sleep.



Play activities planned for the target word /uːʈa/

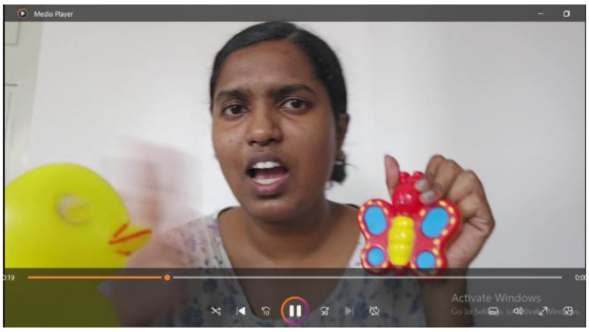
The play activities carried out for the target /uːʈa/ during the play based intervention and mid and post-therapy baseline assessment included the same as that of the target /mamam/, that is eating snacks together, finding what is in the snacks box, serving snacks to each other and to the toys and cooking food.

***Video models for the target word /* haːj/**

Original sample in Kannada: ನನ್ನ ಹತ್ರ ಟಾಯ್ ಫ್ರೆಂಡ್ಸ್ ಇದ್ದಾರೆ. ನಾನು ಟಾಯ್ ಫ್ರೆಂಡ್ಸ್‌ನೆಲ್ಲಾ ವೆಲ್ಕಮ್ ಮಾಡ್ತಿನಿ. ಫಸ್ಟ್ ಬರ್ತಾರೆ ಡಕ್ಕಿ ಟಾಯ್, ಹಾಯ್ ಡಕ್ಕಿ, ಹೆಲೋ!! ಹೆಲೋ ಡಕ್ಕಿ ಟಾಯ್!! ವೆಲ್ಕಮ್ ಟು ದ ಗ್ರೂಪ್ ಡಕ್ಕಿ ಟಾಯ್. ನೆಕ್ಸ್ಟ ಯಾರ್ ಬರ್ತಾರೆ? ನೆಕ್ಸ್ಟ ಇದ್ದಾರೆ ಬಟರ್‌ಫ್ಲೈ, ಹಾಯ್ ಬಟರ್‌ಫ್ಲೈ!! ವೆಲ್ಕಮ್ ಟು ದ ಗ್ರೂಪ್ ಬಟರ್‌ಫ್ಲೈ. ನೆಕ್ಸ್ಟ ಇದ್ದಾರೆ ಡ್ರಾಗನ್. ಹಾಯ್ ಡ್ರಾಗನ್. ಹಾಯ್!! ಡ್ರಾಗನ್‌ಗೆ ಹಾಯ್ ಹೇಳಿ. ನೆಕ್ಸ್ಟ ನಾವು ಸ್ನೇಲ್ ವೆಲ್ಕಮ್ ಮಾಡೋಣ, ಸ್ನೇಲಗೆ ಹಾಯ್ ಹೇಳಣಾ, ಹಾಯ್ ಸ್ನೇಲ್!! ನಮ್ಮ ಹತ್ರ ಟಾಯ್ ಫ್ರೆಂಡ್ಸ್ ಎಲ್ಲ ಬಂದಿದಾರೆ. ಹಾಯ್ ಎಲ್ಲರಿಗೂ.

IPA Phonemic Transcription: /nanna hat̪ra ʈaːj freɳɖs id̪d̪ːaːre ‖/ /naːnu ʈaːj freɳɖsnellaː ʋelkam maːɖt̪ini ‖/ /fasʈ bart̪aːre ɖakːi ʈaːj ‖/ /haːj ɖakːi |/ /heloː |/ /heloː |/ /ɖakːi ʈaːj | ʋelkam ʈu d̪a gruːp ɖakːi ʈaːj ‖/ /neksʈ jaːr bart̪aːre‖/ / haːj baʈarflai ‖/ /ʋelkam ʈu d̪a gruːp baʈarflai ‖/ /neksʈ id̪ːaːre ɖraːgan ‖/ /haːj ɖraːgan ‖/ /haːj ‖/ /ɖraːgange haːj heːɭi‖/ /neksʈ naːʋu sneːl ʋelkam maːɖoːɳa | sneːlge haːj heːɭaɳaː |/ /haːj sneːl ‖/ /namːa hat̪ra ʈaːj freɳɖs ellaː band̪id̪aːre ‖/ /haːj ellaːriguː ‖/

Translation in English: I have toy friends. I welcome all my toy friends. First comes Ducky Toy, hi Ducky, hello!! Hello Ducky Toy!! Welcome to the group, Ducky Toy. Who comes next? Next is Butterfly, hi Butterfly!! Welcome to the group, Butterfly. Next is Dragon. Hi Dragon. Hi!! Say hi to Dragon. Next, we will welcome Snail. Let's say hi to Snail, hi Snail!! All our toy friends have come. Hi everyone.



Play activities planned for the target word /**ha:j/**

The play activities carried out for the target /ha:j/ during the play based intervention and mid and post-therapy baseline assessment included greeting the play toys or games of child's interest such as the clipping the tape game, dropping the coins in the box game, playing with play dough game, sticking the pictures game, playing with the marbles and what's in the bag activity. Additionally child was encouraged to greet when seeing the therapist or entering the room.

Video models for the target word /ba:j/

Original sample in Kannada: ನಾನು ನನ್ನ ಟಾಯ್ ಫ್ರೆಂಡ್ಸ್ ಎಲ್ಲರನ್ನು ಮನೆಗೆ ಕಳಿಸ್ತಿನಿ. ಬಾಯ್ ಬಾಯ್ ಹೇಳಿ ಎಲ್ಲರನ್ನು ಮನೆಗೆ ಕಳಿಸ್ತಿನಿ. ಫಸ್ಟ ಟೆಡಿ ಬೇರ್ಗೆ ಬಾಯ್ ಹೇಳ್ತಿನಿ, ಬಾಯ್ ಬಾಯ್ ಟೆಡಿ ಬೇರ್. ಟೆಡಿ ಬೇರ್ ಬಾಯ್ ಬಾಯ್. ತೆಡಿ ಬೇರ್ ಮನೆಗೆ ಹೋಯ್ತು. ನೆಕ್ಸ್ಟ ಯಾರು ಇದರೆ ನನ್ನ ಟಾಯ್ ಫ್ರೆಂಡ್? ನೆಕ್ಸ್ಟ ಡಕ್ಕಿ ಇದೆ! ಡಕ್ಕಿ ಬಾಯ್ ಬಾಯ್!! ಡಕ್ಕಿ ಬಾಯ್, ನೆಕ್ಸ್ಟ ಡಕ್ಕಿ ಟ್ವಿನ್ ಇದೆ!! ಡಕ್ಕಿ ಟ್ವಿನ್ಗೆ ಬಾಯ್ ಹೇಳ್ತಿನಿ, ಟ್ವಿನ್ ಡಕ್ಕಿ ಬಾಯ್ ಬಾಯ್!! ಬಾಯ್ ಬಾಯ್ ಡಕ್ಕಿ! ಡಕ್ಕಿ ಟ್ವಿನ್ ಮನೆಗೆ ಹೋಯ್ತು. ಅಮೇಲೆ ಫಿಶ್ ಟಾಯ್ಗೆ ಬಾಯ್ ಹೇಳ್ತಿನಿ, ಫಿಶ್ ಟಾಯ್ ಬಾಯ್ ಬಾಯ್!! ಫಿಶ್ ಟಾಯ್ ಬಾಯ್! ಫಿಶ್ ಟಾಯ್ ಮನೆಗೆ ಹೊಗುತ್ತೆ. ನೆಕ್ಸ್ಟ ನಾನು ಬತುಕೋಳಿಗೆ ಬಾಯ್ ಹೇಳ್ತಿನಿ. ಬತುಕೋಳಿ ಟಾಯ್ ಹೊಗ್ತ ಇದೆ. ಬಾಯ್ ಬಾಯ್ ಬಟುಕೋಳಿ! ಬಾಯ್ ಬಾಯ್!! ಬತುಕೋಳಿ ಮನೆಗೆ ಹೋಯ್ತು. ಬಾಯ್ ಬಾಯ್!!

IPA Phonemic Transcription: /naːnu nanna ʈaːj freɳɖs ellaːrannu manege kaɭist̪ini ‖/ /baːj baːj heːɭi ellaranːu manege kaɭist̪ini ‖/ /fasʈ ʈeɖi beːrge baːj heːɭt̪ini ‖/ /baːj baːj ʈeɖi beːr ‖/ /ʈeɖi beːr baːj baːj ‖/ /t̪eɖi beːr manege hoːjt̪u ‖/ /neksʈ jaːru id̪are

|/ /nanna ʈaːj freɳɖ |/ /neksʈ ɖakːi id̪e ǁ/ /ɖakːi baːj baːj ǁ/ /ɖakːi baːj ǁ/ /neksʈ ɖakːi ʈʋin id̪e ǁ/ /ɖakːi ʈʋinge baːj heːɭt̪ini ǁ/ /ʈʋin ɖakːi baːj baːj ǁ/ /baːj baːj ɖakːi ǁ/ /ɖakːi ʈʋin manege hoːjt̪u ǁ/ /ameːle fiʃ ʈaːjge baːj heːɭt̪ini ǁ/ /fiʃ ʈaːj baːj baːj ǁ/ /fiʃ ʈaːj baːj ǁ/ /fiʃ ʈaːj manege hogut̪ːu ǁ/ /neksʈ naːnu bat̪ukoːɭige baːj heːɭt̪ini ǁ/ /bat̪ukoːɭi ʈaːj hogt̪a id̪e ǁ/ /baːj baːj baʈukoːɭiǁ/ /baːj baːj ǁ/ /bat̪ukoːɭi manege hoːjt̪u ǁ/ /baːj baːj ǁ/

Translation in English: I am sending all my toy friends home. Say bye-bye to everyone to send them home. First, I'll say bye to Teddy Bear, bye-bye Teddy Bear. Teddy Bear, bye-bye. Teddy Bear went home. Who is my next toy friend? Next is Ducky! Ducky, bye-bye!! Bye, Ducky. Next is Ducky Twin!! I'll say bye to Ducky Twin, twin Ducky, bye-bye!! Bye-bye, Ducky! Ducky Twin went home. Then I say bye to Fish Toy, Fish Toy, bye-bye!! Fish Toy, bye! Fish Toy is going home. Next, I say bye to the Yellow-Duck. The Yellow-Duck Toy is going. Bye-bye, Yellow-Duck! Bye-bye!! Yellow-Duck went home. Bye-bye!!

Play activities planned for the target word /ba:j/

The play activities carried out for the target /ba:j/ during the play based intervention and mid and post-therapy baseline assessment included greeting all the play toys goodbye once done playing, these were the same play toys or games used for targeting /ha:j/ that is clipping the tape game, dropping the coins in the box game, playing with play dough game, sticking the pictures game, playing with the marbles and what's in the bag activity. Additionally the child was also encouraged to greet goodbye while leaving the therapy session.

Video models for the target word /pɔpɔp/

Original sample in Kannada: ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬ್ಲೋ ಮಾಡಣಾ, ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬರುತ್ತೆ ಈಗ ಪೋಪೋಪ್ ಬಬಲ್ಸ್. ಬಬಲ್ಸ್‌ನ ನಾವು ಪೋಪ್ ಮಾಡಣಾ. ಇನ್ನೊಂದ್ ಸತಿ ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬ್ಲೋ ಮಾಡಣಾ. ನನ್ನ ಹತ್ರ ಬ್ರೌನ್ ಬಬಲ್ಸ್ ಇದೆ, ಬ್ರೌನ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬ್ಲೋ ಮಾಡಣಾ. ಬ್ರೌನ್ ಕಲರ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್, ಅಯ್ಯೋ ಪೋಪೋಪ್ ಬಂದಿಲ್ಲ, ಇನ್ನೊಂದು ಸತಿ ಬ್ಲೋ ಮಾಡಣಾ, ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬಂತು!! ನೆಕ್ಸ್ಟ್ ಈಗ ಪಿಂಕ್ ಬಬಲ್ಸ್ ಬರುತ್ತೆ, ಪಿಂಕ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್, ಪಿಂಕ್ ಕಲರ್ ಪೋಪೋಪ್ ಬಂತು. ವಾವ್!! ಪೋಪೋಪ್ ಮೇಲೆ ಹೋಗ್ತಿದೆ!! ನೆಕ್ಸ್ಟ್ ಗ್ರೀನ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬರುತ್ತೆ, ಗ್ರೀನ್ ಕಲರ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬಂತು, ಯೆಸ್! ಈಗ ನಾವು ಗ್ರೀನ್ ಕಲರ್ ಪೋಪೋಪ್ ಬಬಲ್ಸ್ ಬ್ಲೋ ಮಾಡಿದ್ವಿ.

IPA Phonemic Transcription: /pɔpɔp babals bloː maːɖaɳaː ‖/ /pɔpɔp babals barut̪t̪e iːga ‖/ /pɔpɔp babals ‖/ /babalsna naːʋu poːp maːɖaɳaː ‖/ /innond̪ sat̪i pɔpɔp babals bloː maːɖaɳaː ‖/ /nanna hat̪ra braun babals id̪e ‖/ /braun pɔpɔp babals bloː maːɖaɳaː ‖/ /braun kalar pɔpɔp babals ‖/ /ajjoː pɔpɔp band̪illa ‖/ /innond̪u sat̪i bloː maːɖaɳaː ‖/ /pɔpɔp babals bant̪u ‖/ /neksʈ iːga pink babals barut̪t̪e ‖/ pink pɔpɔp babals ‖/ /pink kalar pɔpɔp bant̪u ‖/ /ʋaːʋ ‖/ /pɔpɔp meːle hoːgt̪id̪e ‖/ /neksʈ griːn pɔpɔp babals barut̪t̪e griːn kalar pɔpɔp babals bant̪u ‖/ /jes ‖/ /iːga naːʋu griːn kalar pɔpɔp babals bloː maːɖid̪ʋi ‖/

Translation in English: Shall we blow pop pop bubbles? Pop pop bubbles are coming now, pop pop bubbles. Let's pop the bubbles. Let's blow pop pop bubbles once more. I have brown bubbles, let's blow brown pop pop bubbles. Brown color pop pop bubbles, oh no, the pop pop didn't come. Let's blow once more, the pop pop bubbles came!! Next, now pink bubbles are coming, pink pop pop bubbles, pink color pop pop came. Wow!! The pop pop is going up!! Next, green pop pop bubbles are coming, green color pop pop bubbles came, yes! Now we have blown green color pop pop bubbles.

Play activities planned for the target word /poːpoːp/

The play activities carried out for the target /pɔpɔp/ during the play based intervention and mid and post-therapy baseline assessment included blowing the bubbles activity, searching for the bubbles and popping the bubbles.

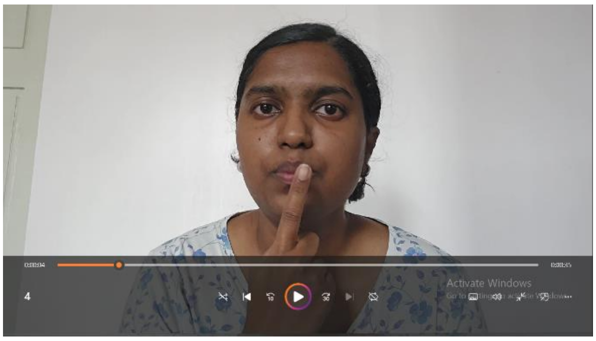
Video models for the target word /pepe/

Original sample in Kannada: ಪೆಪೆ ಪ್ರೆಸ್ ಮಾಡಣಾ, ಪೆಪೆ ಪ್ರೆಸ್ ಬರುತ್ತೆ, ಪೆಪೆ ಬಂತು. ಪೆಪೆ ಡಬ್ಬ ಓಪನ್ ಮಾಡಣ. ಪೆಪೆ ಓಪನ್ ಓಪನ್, ಓಪನ್ ಆಯ್ತು. ಈಗ ನಾವು ಪೆಪೆನ ಪ್ರೆಸ್ ಮಾಡಣಾ! ಓಹ್!! ಇನ್ನೊಂದ್ ಸತಿ ಪೆಪೆ ಪ್ರೆಸ್ ಮಾಡಣಾ. ಒಕೆ ಇವಾಗ, ನನ್ನ ಹತ್ರ ಯೆಲ್ಲೊ ಕಲರ್ ಪೆಪೆ ಪ್ರೆಸ್ ಇದೆ! ಯೆಲ್ಲೊ ಕಲರ್ ಪೆಪೆ ಪ್ರೆಸ್ ಮಾಡಣಾ. ವಾವ್ ಪೆಪೆ ಮೆತ್ತಗಿದೆ! ನೆಕ್ಸ್ಟ್ ಇವಾಗ ಗ್ರೀನ್ ಕಲರ್ ಪೆಪೆ ತಗೊಂಡು ಬರಣ, ಗ್ರೀನ್ ಕಲರ್ ಪೆಪೆ ಡಬ್ಬ ಇದೆ, ಓಪನ್ ಓಪನ್! ಓಪನ್ ಆಯ್ತು!! ಗ್ರೀನ್ ಪೆಪೆ ಪ್ರೆಸ್ ಮಾಡಿದ್ವಿ. ಇನ್ನೊಂದು ಸತಿ ಪ್ರೆಸ್ ಮಾಡಣಾ, ಪೆಪೆ ಪ್ರೆಸ್! ಪೆಪೆ ಪ್ರೆಸ್!! ಯೆಸ್!! ಪೆಪೆ ಪ್ರೆಸ್ ಆಯತು !! ಪೆಪೆ ಪ್ರೆಸ್‌ಗೆ ಬಾಯ್ ಹೇಳಣ!! ಯೆಲ್ಲೊ ಪೆಪೆ ಕ್ಲೋಸ್ ಮಾಡ್ದೆ. ನೆಕ್ಸ್ಟ್ ಗ್ರೀನ್ ಪೆಪೆ ಕ್ಲೋಸ್ ಮಾಡ್ದೆ. ಒಕೆ ಈಗ ಪೆಪೆ ಪ್ರೆಸ್ಗೆ ಬಾಯ್ ಹೆಳೋಣ. ಬಾಯ್ ಯೆಲ್ಲೊ ಪೆಪೆ. ಬಾಯ್ ಗ್ರೀನ್ ಪೆಪೆ. ಪೆಪೆ ಪ್ರೆಸ್ ಆಯ್ತು.

IPA Phonemic Transcription: /pepe pres maːɖaɳaː ‖/ /pepe pres barut̪t̪e ‖/ /pepe bant̪u ‖/ /pepe ɖabba oːpan maːɖaɳa ‖/ /pepe oːpan oːpan ‖/ /oːpan aːjt̪u ‖/ /iːga naːʋu pepena pres maːɖaɳaː ‖/ /oːh inːond̪ sat̪i pepe pres maːɖaɳaː ‖/ /oke iʋaːga ‖/

/nanna hat̪ra jello kalar pepe pres id̪e ǁ/ /jello kalar pepe pres maːɖaɳaː ǁ/ /ʋaːʋ pepe met̪ːagid̪e ǁ/ /nekstʈ iʋaːga griːn kalar pepe t̪agoɳɖu baraɳa ǁ/ /griːn kalar pepe ɖabba id̪e ǁ/ /oːpan oːpan ǁ/ /oːpan aːjt̪u ǁ/ /griːn pepe pres maːɖid̪ʋi ǁ/ /innond̪u sat̪i pres maːɖaɳaː ǁ/ /pepe pres ǁ/ /pepe pres ǁ/ /jes ǁ/ /pepe pres aːjat̪u ǁ/ /pepe presge baːj heːɭaɳa ǁ/ /jello pepe kloːs maːɖd̪e ǁ/ /nekstʈ griːn pepe kloːs maːɖd̪e oke iːga pepe presge baːj heɭoːɳa ǁ/ /baːj jello pepe ǁ/ /baːj griːn pepe ǁ/ /pepe pres aːjt̪u ǁ/

Translation in English: Shall we press the pepe slime? The pepe slime is coming. The pepe slime came. Let's open the pepe slime container. Pepe slime open, open, it's open. Now let's press the pepe slime! Oh!! Shall we press the pepe slime once more? Okay, now, I have yellow pepe slime! Let's press the yellow pepe slime. Wow, the pepe slime is soft! Next, now I will bring green pepe slime, there is a green pepe slime container, open, open! It's open!! We pressed the green pepe slime. Shall we press it once more, press the pepe slime! Press the pepe slime!! Yes!! The pepe slime is pressed!! Let's say bye to the pepe slime!! Closed the yellow pepe slime. Closed the green pepe slime. Okay, now let's say bye to the pepe slime. Bye yellow pepe slime. Bye green pepe slime. The pepe slime pressing is done.



Play activities planned for the target word /pepe/

The play activities carried out for the target /pepe/ during the play based intervention and mid and post-therapy baseline assessment included playing with the slime of different colors, to dip fingers, squeeze or to make shapes with the slime.

Video models for the target word /aːbu/

Original sample in Kannada: ನಾವು ಗ್ಲಾಸ್‌ಗೆ ಆಬು ಹಾಕಣ, ಮೊದ್ಲು ಚಿಕ್ಕ ಗ್ಲಾಸ್‌ಗೆ ಆಬು ಹಾಕಣ. ಈಗ ನಾವು ಚಿಕ್ಕ ಗ್ಲಾಸ್‌ಗೆ ಆಬು ಹಾಕಿದ್ವಿ, ಏನ್ ಹಾಕಿದ್ವಿ? ಆಬು ಹಾಕಿದ್ವಿ. ಈಗ ದೊಡ್ಡ ಗ್ಲಾಸ್‌ಗೆ ಆಬು ಹಾಕಣ. ಒಕೆ! ಆಬು ದೊಡ್ಡ ಗ್ಲಾಸ್‌ಗೆ ಹಾಕಿದ್ವಿ. ನಂಗೆ ಬಾಯಾರಿಕೆ ಆಗ್ತಾ ಇದೆ, ಏನ್ ಮಾಡ್ಲಿ? ಆಬು ಕುಡಿತಿನಿ, ಅಮ್ಮ ನಂಗೆ ಆಬು ಬೇಕು, ಆಬು ಕೊಡಿ. ನಾನು ಆಬು ಕುಡಿತಿನಿ. ನಾನು ಆಬು ಕುಡ್ದೆ. ನಾವು ಆಬು ಯಾವುದ್ರಲ್ಲಿ ಕುಡಿತಿವಿ? ನಾವು ಆಬು ಗ್ಲಾಸ್ ಅಲ್ಲಿ ಕುಡಿತಿವಿ. ಇಲ್ಲ ಯಾವುದ್ರಲ್ಲಿ ಆಬು ಕುಡಿತಿವಿ? ಬೊಟಲ್ ಅಲ್ಲಿ ಕುಡಿತಿವಿ. ಆಬುನ ನಾವು ಬೊಟಲ್ಗೆ ಹಾಕಿ ಆಮೇಲೆ ಬಾಯಾರಿಕೆ ಆದಾಗ ಕಡಿತಿವಿ. ಇಲ್ಲಿ ನೋಡಿ ನನ್ನ ಬೊಟಲ್ ಅಲ್ಲಿ ಆಬು ಇದೆ. ಏನು ಇದೆ? ಆಬು! ಆಬು ಇದೆ.

IPA Phonemic Transcription: /naːʋu glaːsge aːbu haːkaɳa ‖/ /mod̪lu tʃikka glaːsge aːbu haːkaɳa ‖/ /iːga naːʋu tʃikka glaːsge aːbu haːkid̪ʋi ‖/ /eːn haːkid̪ʋi ‖/ /aːbu haːkid̪ʋi ‖/ /iːga d̪oɖːa glaːsge aːbu haːkaɳa ‖/ /oke ‖/ /aːbu d̪oɖːa glaːsge haːkid̪ʋi ‖/ /nange baːjaːrike aːgt̪aː id̪e ‖/ /eːn maːɖli aːbu kuɖit̪ini ‖/ /ammaː nange aːbu beːku ‖/ /aːbu koɖi ‖/ /naːnu aːbu kuɖit̪ini ‖/ /naːnu aːbu kuɖd̪e ‖/ /naːʋu aːbu jaːʋud̪ralli kuɖit̪iʋi ‖/ /naːʋu aːbu glaːs alli kuɖit̪iʋi |/ /illa jaːʋud̪ralli aːbu kuɖit̪iʋi ‖/ /boʈal alli kuɖit̪iʋi ‖/ /aːbuna naːʋu boʈalge haːki aːmeːle baːjaːrike aːd̪aːga kaɖit̪iʋi ‖/ /illi noːɖi nanna boʈal alli aːbu id̪e ‖/ /eːnu id̪e aːbu ‖/ /aːbu id̪e ‖/

Translation in English: Let's put water in the glass. First, let's put water in the small glass. Now we have put water in the small glass, what did we put? We put water. Now let's put water in the big glass. Okay! We have put water in the big glass. I feel thirsty, what should I do? Drink water, mom, I want water, give me water. I am drinking water. I am drinking water. Where are we drinking water? We are drinking water in the water glass. No, where are we drinking water? In the bottle. We put water in the bottle, and then we drank when we felt thirsty. Look here, there is water in my bottle. What's there? Water! There is water.

Play activities planned for the target word /aːbu/

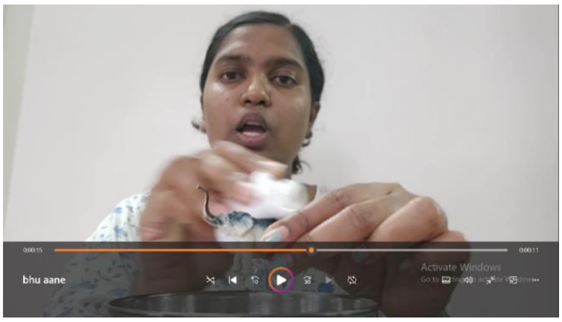
The play activities carried out for the target /aːbu/ during the play based intervention and mid and post-therapy baseline assessment included bathing the letters models of child’s interest, bathing the marbles, watering the plant, requesting for the water bottle to drink water and blow into water cup to form bubbles.

Video models for the target word /buʃ/

Original sample in Kannada: ನಾವು ಈಗ ಬುಶ್ ಬುಶ್ ಮಾಡ್ಸಣ. ಬುಶ್ ಬುಶ್ ಬುಶ್!! ಮೊದಲು ಆನೆಗೆ ಬುಶ್ ಬುಶ್ ಮಾಡ್ಸಣ. ಇವಾಗೆ ಆಬು ಹಾಕಿ ಆನೆಗೆ ಬುಶ್ ಬುಶ್ ಮಾಡ್ಸಿದ್ವಿ. ಆನೆಗೆ ಬುಶ್ ಬುಶ್ ಆಯ್ತು. ಆನೆ ಬುಶ್ ಬುಶ್ ಮುಗ್ಸಿ ಟೊವೆಲ್ ಹಾಕ್ಕೊಂಡು, ಮೈ ಒರಿಸ್ಕೊಂಡು ಬಂತು. ನೆಕ್ಸ್ಟ್ ಇವಗ ಯಾರಿಗೆ ಬುಶ್ ಬುಶ್ ಮಾಡ್ಸೋಣ, ನೆಕ್ಸ್ಟ್ ನಾವು ಡೋಂಕಿಗೆ ಬುಶ್ ಮಾಡ್ಸಣ. ಆಬು ಹಾಕಣ ಫರ್ಸ್ಟ್, ಆಬು ಹಾಕಿ ಬುಶ್ ಬುಶ್ ಮಾಡ್ಸಿದ್ವಿ. ಡೋಂಕಿ ಕೂಡ ಬುಶ್ ಬುಶ್ ಮುಗ್ಸಿ ಟೊವೆಲ್ ಹಾಕ್ಕೊಂಡು, ಮೈ ಒರಿಸ್ಕೊಂಡು ಬಂತು. ಇದೇ ರೀತಿ ನಾವೆಲ್ಲ ದಿನಾ ಬೆಳಿಗ್ಗೆ ಅಥ್ವ ಸಂಜೆ ಬುಶ್ ಬುಶ್ ಮಡ್ತಿವಿ.

IPA Phonemic Transcription: /naːʋu iːga buʃ buʃ maːɖsaɳa ‖/ /buʃ buʃ buʃ ‖/ /mod̪alu aːnege buʃ buʃ maːɖsaɳa ‖/ /iʋaːge aːbu haːki aːnege buʃ buʃ maːɖsid̪ʋi ‖/ /aːnege buʃ buʃ aːjt̪u ‖/ /aːne buʃ buʃ mugsi ʈoʋel haːkːoɳɖu maj oriskoɳɖu bant̪u ‖/ /nekstʈ iʋaga jaːrige buʃ buʃ maːɖsoːɳa ‖/ /nekstʈ naːʋu ɖoːnkige buʃ maːɖsaɳa ‖/ /aːbu haːkaɳa farsʈu ‖/ /aːbu haːki buʃ buʃ maːɖsid̪ʋi ‖/ /ɖoːnki kuːɖa buʃ buʃ mugsi ʈoʋel haːkːoɳɖu maj oriskoɳɖu bant̪u ‖/ /id̪eː riːt̪i naːʋelːa d̪inaː beɭigːe at̪ʰʋa sandʒe buʃ buʃ maɖt̪iʋi ‖/

Translation in English: Now let's bathe. Bathing, bathing, bathing!! First, let's bathe the elephant. We've put water and bathed the elephant. The elephant has bathed. The elephant rinsed and dried itself with a towel. Next, who shall we bathe? Next, let's bathe the donkey. First, let's put water, and then we bathed the donkey. The donkey also rinsed and dried itself with a towel. This way, every morning or evening, we enjoy bathing.



Play activities planned for the target word /buʃ/

The play activities carried out for the target /buʃ/ during the play based intervention and mid and post-therapy baseline assessment included the same as that of ones used with /aːbu/ which includes bathing the letters models of child’s interest, bathing the marbles and additionally bathing animal models.

Video models for the target word /pupu/

Original sample in Kannada: ನನ್ನ ಹತ್ರ ಪುಪು ಬೈಗ್ ಇದೆ. ಇದು ನನ್ನ ಪುಪು ಬೈಗ್. ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ ಏನ್ ಇದೆ ನೋಡಣ. ಪುಪು ಬೈಗ್ ಓಪನ್ ಮಾಡಣ. ಓಪನ್ ಓಪನ್ ಪುಪು ಬೈಗ್ ಓಪನ್ ಆಯ್ತು. ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ ಕಿಚನ್ ಐಟಂಸ್ ಇದೆ. ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ ಕಿಚನ್ ಟಾಯ್ಸ ಇದೆ. ನಿನ್ನ ಹತ್ರ ಪುಪು ಬೈಗ್ ಇದೆ ಅಲ್ಲ ಅದೇ ರೀತಿ ಇದು ನನ್ನ ಪುಪು ಬೈಗ್. ಇನ್ನೊಂದು ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ ಏನ್ ಇದೆ ನೋಡಣ. ಪುಪು ಬೈಗ್!! ಪುಪು ಬೈಗ್!! ವಾವ್!! ಈ ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ ಬ್ಲಾಕ್ಸ್ ಇದೆ. ಆಮೆಲೆ ಏನ್ ಇದೆ ಪುಪು ಬೈಗ್ ಅಲ್ಲಿ. ಆಮೆಲೆ ಟಾಯ್ಸ್ ಇದೆ. ಒಕೆ! ಈಗ ಪುಪು ಬೈಗ್ ಎಲ್ಲಾನು ಕ್ಲೋಸ್ ಮಾಡಣ. ಪುಪು ಬೈಗ್ ಕ್ಲೋಸ್ ಆಯ್ತು! ಬಾಯ್ ಪುಪು ಬೈಗ್!

IPA Phonemic Transcription: /nanna hat̪ra pupu bæg id̪e ‖/ /id̪u nanna pupu bæg ‖/ /pupu bæg alli eːn id̪e noːɖaɳa ‖/ /pupu bæg oːpan maːɖaɳa ‖/ /oːpan oːpan pupu bæg oːpan aːjt̪u ‖/ /pupu bæg alli kitʃan ajʈams id̪e ‖/ /pupu bæg alli kitʃan ʈaːjsa id̪e ‖/ /ninna hat̪ra pupu bæg id̪e alla ad̪eː riːt̪i id̪u nanna pupu bæg ‖/ /innond̪u pupu bæg alli eːn id̪e noːɖaɳa ‖/ /pupu bæg ‖/ pupu bæg ‖/ /ʋaːʋ ‖/ /iː pupu bæg alli blaːks id̪e ‖/ /aːmele eːn id̪e pupu bæg alːi ‖/ /aːmele ʈaːjs id̪e ‖/ /oke ‖/ /iːga pupu bæg elːaːnu kloːs maːɖaɳa ‖/ /pupu bæg kloːs aːjt̪u ‖/ /baːj pupu bæg ‖/

Translation in English: I have pupu bag with me. This is my pupu bag. Let's see what's in the pupu bag. Open the pupu bag. Open! Open! pupu bag is open! There are kitchen items in the pupu bag. There are kitchen toys in the pupu bag. Just like your pupu bag this one is my pupu bag. Let's see what's in the other pupu bag. Pupu bag!! Pupu bag!! Wow!! There are blocks in this pupu bag. What's next in the pupu bag? There are toys. Okay! Now let's close the pupu bag. Pupu bag is closed! Bye pupu bag!

Play activities planned for the target word /pupu/

The play activities carried out for the target /pupu/ during the play based intervention and mid and post-therapy baseline assessment included exploring what is in the child's bag that is named 'pupu', the child was encouraged to question 'what's in the bag?' by tapping on the bag while saying the target word in order to get the toys his interest that would be placed inside the bag.

Appendix C

Sample of consent letter

Information to the Participants

Dear parents,

I, Ms. Sahaja.M, a second-year Master's student in Speech-Language Pathology, currently engaged in my dissertation, intend to investigate the impact of a novel therapeutic approach known as Autism Centered Therapy for Childhood Apraxia of Speech on the speech and language skills of minimally verbal children with Autism Spectrum Disorder. This study aims to explore an intervention method that effectively addresses expressive language skills in the target population while reducing client frustration during therapy sessions.

The research procedures involved in this study will be slightly different from the standard medical or therapeutic care activities conducted at the institute. Your participation in the study is estimated to be approximately 2-3 months, with therapy sessions scheduled three days per week, according to the designated days and timings. I assure you that there are no inherent risks associated with participating in this study; rather, it is anticipated to be beneficial for your child's developmental progress.

During the study, responses will be recorded in either audio or video format for subsequent analysis. I would like to emphasize that confidentiality will be strictly maintained throughout the research process. It is important to note that there is absolutely no external influence or pressure exerted on your decision to participate in this study. Your cooperation and participation in this research are greatly appreciated.

Informed Consent

I have been informed about and understand the purpose of the study and my child's participation in it. The possible benefits of my child's participation as human subject in the study are clearly understood by me. I understand that I have a right to refuse participation as subject or withdraw my consent at any time without adversely affecting my/my ward's treatment at AIISH. I give my consent for my child's participation in this study.

I, ____, the undersigned, give my consent for my child's participation in this study.

(AGREE/DISAGREE)

Signature of Parent/Guardian	Signature of Investigator
(Name and Address)	(Name and Designation)