DEVELOPMENT OF A RESOURCE MANUAL IN KANNADA FOR TRAINING PHONOTACTIC STRUCTURE IN CHILDREN WITH APRAXIA OF SPEECH

M KUSUMA

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A Dissertation submitted in part fulfilment for the degree of Masters of Science in Speech-Language Pathology

University of Mysuru,

Mysuru

ALL INDIA INSTITUTE OF SPEECH AND HEARING

Manasagangothri, Mysuru 570 006

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CERTIFICATE

This is to certify that this dissertation entitled **'Development of a Resource Manual In Kannada For Training Phonotactic Structure In Children With Apraxia Of Speech'** is a bonafide work submitted in part fulfilment for the degree of Master of Science (Speech-Language Pathology) by the student Registration Number: 19SLP017. This has been carried out under the guidance of a faculty member of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru

September, 2021

Dr. M. Pushpavathi

Director

All India Institute of Speech and Hearing

Manasagangothri

Mysuru 570006

CERTIFICATE

This is to certify that this dissertation entitled **'Development of a Resource Manual In Kannada For Training Phonotactic Structure In Children With Apraxia Of Speech'** has been carried out under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
September, 2021

Dr. Swapna N
Guide
Associate Professor of Speech Pathology,
Department of Speech-Language Pathology,
All India Institute of Speech and Hearing
Manasagangothri, Mysuru 570 006

DECLERATION

This is to certify that this dissertation entitled **'Development of a Resource Manual In Kannada For Training Phonotactic Structure In Children With Apraxia Of Speech'** is the result of my own study under the guidance of Dr. Swapna. N., Associate Professor in Language Pathology, Department of Speech-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: 19SLP017**

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CHAPTER I

INTRODUCTION

Childhood Apraxia of Speech (CAS) is a rare, neurological childhood (paediatric) speech sound disorder, in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits (e.g., abnormal reflexes, abnormal tone). CAS may occur as a result of known neurological impairment, in association with complex neurobehavioral disorders of known or unknown origin, or as an idiopathic neurogenic speech sound disorder. The core impairment in planning and/or programming spatio-temporal parameters of movement sequences results in errors in speech sound production and prosody (American Speech-Language-Hearing Association., ASHA, 2007a). As stated in the definition proposed by ASHA, the cause of CAS is neurological, which affects the motor planning and programming of speech.

The children with CAS exhibit difficulty with fine, rapid and voluntary movements necessary to produce speech that may be directly influenced by context (Strand & Skinder, 1999; Yorkston et al., 2010). Thus the most salient features of CAS are articulatory and prosodic disturbances due to impaired motor planning and/or programming. According to ASHA (2007b), CAS is best characterized as a symptom complex rather than as a unitary disorder and that it may affect, to varying degrees, some combination of nonspeech motor behaviours, speech motor behaviours, production of speech sounds and structure (words and syllable shape), prosody, language, metalinguistic/phonemic awareness and literacy. They could have difficulty initiating, achieving, and maintaining articulatory configuration, difficulty in sequencing phonemes, difficulty in transition or moving from one articulatory movement to the other, groping movements or trial and error behaviour for achieving

the appropriate spatial target, distortions in intended vowel production, inconsistent voicing errors, difficulty in imitating phonemes and increased prosodic errors (Shriberg et al., 2011; Shriberg et al., 2012; Strand et al., 2013; Yoss & Darley, 1974). However, all these core features need not be present in all children with CAS. The symptoms expressed could be highly variable among them.

Treatment for CAS focuses on improving motor planning and programming abilities and linguistic abilities, to help the child with CAS to articulate sounds clearly and to effortlessly sequence these sounds appropriately into words and sentences. The treatment approaches for CAS include Motor based approaches, which are based on principles of motor learning, Linguistic approaches, which focuses on the phonology, semantics and syntax of the language, and not on motor speech production and Multi-modal communication approaches, which support verbal communication with the help of aided AAC (Augmentative and Alternative Communication) modelling (Binger, 2007), or use of technological devices (Bornman et al., 2001; Cumley & Swanson, 1999).

Production of speech sounds and combining them to form words is one area of difficulty for children with CAS, which are targeted through the motor approaches. Phonemes are often produced with greater accuracy in isolation than in longer sequences (Grigos et al., 2015). Motor sequencing in terms of sequencing phonemes and transition from one phoneme to the next, consonant to vowel and vice versa are challenging for these children (Ayres, 1985, as cited in Velleman, 2002). Therefore, syllable structure control and organization within a variety of dynamic linguistic contexts should be the major focus during intervention. Any treatment protocol must include repetitive, intensive practice from one consonant position to various vowel targets and from various consonants to one particular vowel target, facilitating

accurate production of varying syllable shapes, organising them into longer and complex phonotactic patterns (Velleman, 2006).

Velleman (2002) described the phonotactic therapy and noted that the immature phonotactic patterns require intervention that focuses on syllable level and that the therapy that addresses syllable shapes has the potential to evoke generalization well beyond the specific sounds or sounds targeted in the particular syllable position. She proposed a hierarchy of phonotactic pattern from simple to complex, which is as follows: Simple open syllables (CV), reduplicated open syllables (CVCV -- same syllable repeated as in "bye-bye"), harmonized (C or V) non-reduplicated disyllabic open syllable forms (CVCV), non-harmonized non-reduplicated disyllabic open syllable forms, harmonized closed syllables, non-harmonized closed syllables, CVCVC words (reduplicated, harmonized, or neither) and words with initial, medial, and/or final clusters (Velleman, 2002). However, this pattern can vary with languages. For example, Kannada is a syllabic language with CV, VC, CVC, CCVC, VCV, VCVCV, CVCCV etc. Both open and closed syllables are there in Kannada. However, most frequently occurring are open disyllable word shapes, followed by trisyllables and multisyllables (Rupela & Manjula, 2006). Further, in Kannada, two vowels do not occur consecutively (Rajpurohit, 1975; Rupela &Manjula, 2007).

It is important to consider the phonotactic structure of language and target it in the treatment for children with CAS in order to broaden the oral-motor organizational capability and to increase ability in novel word learning. Repetitive and intensive treatment beginning from simple syllabic structures, moving on to lengthy, complex word shapes is necessary for improvement in motor planning and programming. This

helps in response generalisation from learnt words or patterns to similar other words which are not taught or even in learning novel words.

NEED FOR THE STUDY

A look into the literature revealed that there are very limited resource materials or manuals that focus on teaching syllable structure for children with CAS. It is important to plan treatment in a hierarchical form, like simple to complex (as emphasised by motor treatment approaches), unmarked to marked sounds etc. Efforts to developing resource materials in this regard are limited.

There are many manuals, apps and products, which are available for the treatment of apraxia of speech such as Kaufman's speech praxis treatment kit for children – advanced level (Kaufman, 2001), Nuffield Dyspraxia programme 3 (NDP3) (Williams & Stephens, 2004), speech therapy for apraxia app (http://nacd.org), Webber MINI apraxia photo cards (*Webber MINI Apraxia Photo Cards | Product Info*, n.d.), Preschool Apraxia cards (Mulstay-Muratore, 2010), The source for CAS (Downing & Chamberlin, 2006), SPARC for CAS (LinguiSystems, 2013), LinguiSystems apraxia card app (LinguiSystems, 2012) etc. for children. These are systematic and structured with increasing linguistic complexity, however all these are developed in English.

India is a multilingual country and teaching the sounds/phonemes is language specific. Hence there is a need to develop treatment manuals in various Indian languages. There are treatment manuals for apraxia in Hindi (Rupela & Manjula, 2008) and Malayalam (Sneha & Manjula, 2008) language, which focus on oromotor exercises, teaching phonemes at isolation, syllable and at word level. They guide the reader for initiating and/or shaping the child's expressive speech. However, these

manuals are developed viewing CAS as an executive disorder and not a motor planning, programming disorder. These manuals do not consider the phonotactic structure and complexity for developing the stimulus list for treatment. This necessitates the development of well structured treatment manual in Kannada for teaching phonotactic structures.

This manual that will be developed will help in improving verbal expressive skills by improving phonetic and phonotactic repertoire in Kannada speaking children with CAS. Impaired phonotactic skills are also seen in children with phonological disorders, therefore, the manual can be used with these children as well. This will facilitate the acquisition of phonemes and their usage in words in a fun filled manner.

AIM: To develop a manual for training the phonotactic structure in Kannada speaking children with Apraxia of Speech.

Objectives: (1) To develop a manual for training the phonotactic structure in Kannada (2) To validate the content of the manual.

CHAPTER II

Review of Literature

Childhood apraxia of speech (CAS), a motor speech disorder, is a condition with difficulty in planning and programming speech movements. There is disruption in the cortical processes specifically sensory-motor processes, which interfere with motor learning of speech movements causing delay/deviance in planning and programming sequences of speech movements (Cumley et al., 2001).

Epidemiological studies in the area of CAS are very limited. Morley (1972) reported that estimated population-based prevalence of CAS was 1.3 children per 100. Yoss (1975) reported similar results, with estimated population-based prevalence of CAS as 1 child per 100. Shriberg et al., (1997) estimated the population-based prevalence to be 1- 2 children per 1,000 based on the referrals to a university speech clinic in one city. Recently, Shriberg et al., (2019) reported the estimated population-based prevalence of idiopathic CAS as 1 in 1000 children. Idiopathic CAS is more prevalent in males than in females (Hall et al., 1993; Lewis et al., 2004; McNeil, 2009), however recent evidences exist showing that the prevalence of CAS is almost same for both males and females (McNeil, 2009; Shriberg, 2010).

Aetiology of CAS

Isolated CAS is a very rare condition. CAS may co-occur with other conditions such as Down syndrome, autism, fragile X syndrome, 16p11.2 microdeletion syndrome, 22q11.2 deletion syndrome, galactosemia etc. (Raca et al., 2013). Wilson et al., (2019) have reported that 1 out of 4 individuals with Down syndrome have childhood dysarthria and CAS. 3 – 4% of children with speech sound disorders had CAS and out of 15,000 referrals of speech delay cases of unknown

origin, 4% of children showed CAS (Delaney & Kent, 2004). The prevalence of CAS is estimated to be 18 per 100 in galactosemia (Shriberg et al., 2011). Researchers have reported that the co-occurrence of CAS with language disorder may vary from 46 to 82% (Thoonen et al., 1997; Lewis et al., 2004; Iuzzini, 2012; Vuolo & Goffman, 2018; Zuk et al., 2018; Murray et al., 2019 as cited in Malmenholt, 2020).

The aetiology, location and neuropathology of isolated CAS are unknown. It is associated with known neurological causes such as intrauterine infections, injuries, stroke, trauma (ASHA, 2007b). Neuroimaging studies such as MRI is not sensitive enough to identify neural impairments in children with idiopathic CAS indicating that the damage is not at the macroscopic level. However, MRI studies on children with CAS, associated with mutation of FOXP2 gene reveals possible impairment in rolandic cortices, inferior frontal cortices, basal ganglia and cerebellum (Morgan & Webster, 2018). CAS co-occurs with other conditions such as mutation of FOXP2 gene (genetically based impairments), Down syndrome, Autism (neurological disorders) etc. It is also associated with developmental delays, prenatal/perinatal insults such as infections during gestational period, premature birth and low birth weight (Fox et al., 2002). Differences in the rate of development/quality of myelination can also be observed in few children with CAS (Cumley et al., 2001).

Characteristics of CAS

CAS is not a unitary disorder but is a symptom complex or in other words, it has a spectrum of characteristics. Children with CAS have difficulty in precise and accurate production of speech movements. Researchers have reported (a) inconsistent consonant and vowel errors (b) disrupted coarticulatory transitions and (c) inappropriate prosody in children with CAS and these are considered as inclusionary criteria for diagnosing CAS. Inconsistent consonant and vowel errors may include

production of a particular phoneme in particular context correctly, but may fail to produce the same in another context (for example, child is able to accurately produce /s/ in the initial position, but may not be able to produce it in medial or final position) or, child may use different phoneme every time when he/she tries to produce the same word (For example, in a multiple repetition task of “bat”, child may say “pat”, “bat”, “bad”, “pet” etc.) or may produce the word correctly sometimes but may fail to produce the same word correctly the next time. Many researchers use inconsistency in speech production as the major criteria for classifying the disorder as CAS. Children with CAS also have difficulty in moving from one phoneme to the next. They often perform poor on repetition of sequence of phonemes. The diadochokinetic rate, especially, sequential motor rate is often poor. They may combine two to three articulatory movements to a single articulatory gesture. The desired articulatory movements may be performed after few attempts. They may have narrowed phonetic repertoire. The difficulty in speech increases as the word length or complexity increases. So they may find it relatively easier to produce monosyllables and bisyllables of simple structure than polysyllables or words with clusters or complex structure. They usually speak in short and simple words or phrases. Volitional speech is more difficult than automatic speech. The speech of children with CAS may be perceived as scanned speech, with equal stress on every sound/word, or can be staccato kind due to prolonged pauses within and between words as well as due to lack of smooth transition from one phoneme to the next. The range of pitch and loudness variation is less leading to perceived monotonous speech. Frequent characteristics of CAS include slow or delayed development of speech, delayed first word acquisition, reduced phonemic inventories, phonotactic deficits (difficulty producing complex syllable shapes), vowel distortions, multiple speech sound errors,

decreased percentage of phonemes correct (reduced percentage of consonants correct and percentage of vowels correct), unintelligible speech as complexity increases and regression of verbal speech skills (loss of phonemes/words/syllable shapes that was previously mastered). Phonological and phonetic errors become evident as the complexity of word structure increases.

Two hundred and sixty speech-language pathologists (SLPs) participated in a survey on speech characteristics of children with CAS and according to the results of the survey, 86.9% reported inconsistency, 75% reported sequencing errors and low speech intelligibility, 72.7% reported groping errors, 72.3% reported slow diadochokinetic rate, 66.2% reported impaired articulatory configuration, 62.7% reported difficulty with polysyllabic words, 56.2% reported suprasegmental disturbances and 53.5% reported metathesis as speech characteristics of children with CAS (Shakibayi et al., 2019).

Recent researches have tried to understand and identify early indicators for CAS. Volubility, that is, the amount of vocalisation produced, during toddlers, was significantly lower in children later identified as CAS compared to typically developing children, but the volubility was not so significant between children with CAS and SLI (Highman et al., 2008). Parents of children with CAS have reported impairment in babbling stage itself, wherein, babbling was not present at all, or limited babbling or limited phonemes in babbling were present (Davis & Velleman, 2000). Atypical vocal development such as delay in canonical babbling is associated with CAS (Rvachew & Brosseau-Lapre, 2012; Velleman & Strand, 1994). Syllable structures were limited to simple monosyllables like V, CV and VC and bisyllables like VCV, CVCV and VCVC in infants and toddlers who were later diagnosed as CAS (Overby & Caspari, 2015). It is not necessary that all the above-mentioned

characteristics must be present in all children with CAS or to diagnose an individual with CAS. There is heterogeneity among the characteristics expressed in individuals with CAS.

CAS is a disorder with both phonological and phonetic component. Froud & Khamis-Dakwar (2012) conducted Mismatch Negativity study on 5 children with CAS and 5 typically developing children in the age range of 5-8years. Immature MMN response was observed in children with CAS. MMN like response was observed for allophonic contrast in CAS population, but was not observed in the typically developing group indicating atypical phonological and phonetic processing in children with CAS. Authors concluded that not only motor programming, but the phonological component is also affected.

The results of three different tasks, namely, syllable awareness, intrasyllabic position and intrasyllabic structure administered on three children with CAS was compared with the performance of three typically developing children. All the children were in the age range of 6-8 years. Scores on perception of syllableness, intrasyllabic position and structure was relatively less for children with CAS compared to typically developing children indicating impaired phonological representation system in children with CAS (Marquardt et al., 2002).

Few authors investigated whether the speech errors observed in children with CAS involved the impairment at the level of phoneme perception. Maassen et al., (2003) conducted vowel perception study on 11 children with CAS and 12 typically developing children in the age range of 6.11 to 9.6 years. Series of vowels /i/ - /I/ and /a/ - /ɑ/ were presented by changing the formant frequencies towards a neutral vowel position from extreme values in vowel space. Authors reported that children with

CAS required more difference to differentiate between the vowels presented on a continuum indicating poor auditory processing, and to identify those indicating poor phonetic processing skills.

Zuk et al., (2018) conducted speech perception study on 47 children (7 children with CAS without language impairment, 6 children with CAS with language impairment, 7 children with language impairment alone, 12 children with speech delay and 15 typically developing children) in the age range of 4.7 – 17.7 years. They were presented with two discrete pairs of stimuli at a time with more contrast at the beginning (/da/ and /ga/) progressing to reduced distinctiveness. Results revealed that children with CAS along with language impairment had more difficulty in discriminating sounds compared to isolated CAS and typically developing children. Children with CAS alone and typically developing children did not differ significantly on the discrimination task. Authors concluded that impaired speech perception is not a core deficit of CAS, but is due to the language impairment associated with CAS.

Impairment in phonological skills further affects the academic skills. Children with CAS have difficulty with metalinguistic awareness. Hence, children with CAS are at greater risk for developing difficulty in literacy skills.

Assessment of CAS

It is difficult to diagnose this condition as it is a dynamic speech disorder. The symptoms or characteristics may change over time. A child with CAS may progress to a point such that the characteristics presented may be more appropriately labelled as articulation errors or phonological impairment (Strand & McCauley, 2008; Ebert, 2017). Longitudinal studies conducted on children with CAS reveal that “slow multisyllable repetition rate is a useful endophenotype for CAS because it persists

even after speech accuracy has normalised" (Rvachew & Brosseau-Lapre, 2012, pp. 537). Diagnosing CAS in children below 3 years of age is challenging because (1) CAS cannot be formally diagnosed till the child is verbal, (2) Rapid neural development takes place during this age and (3) the symptoms presented may change over time due to neural maturation.

There are no gold standard factors that differentially diagnose CAS from other speech sound disorders. Currently, there exists no study with highest diagnostic quality that aids in differential diagnosis of CAS from other speech sound disorders (Murray et al., 2021). Researchers have found that, accuracy of polysyllable production in conjunction with oral motor examination, which includes DDK to be sufficient to identify CAS (Murray, McCabe, Heard et al., 2015). Further, Pause Marker also helps distinguish CAS from speech delay and other types of motor speech disorders. Pause marker is any pause of atleast 150ms between words or at inappropriate linguistic places in continuous speech. A pause marker score of less than 94% is indicative of CAS. Pause Marker Index classifies CAS into different severity such as, mild CAS for PMI of 90 – 93.9% PMI, mild – moderate CAS for 85 – 89.9% PMI, moderate – severe CAS for 80 – 84.9% PMI and severe CAS for less than 80% PMI (Tilkens et al., 2017). According to a study conducted by Shriberg et al., (2017) pause marker is a near conclusive diagnostic marker of CAS.

Assessment batteries for CAS must evaluate the oral motor skills (diadochokinetic rate, oral apraxia etc) and speech and language (segmental and suprasegmental aspects). There are several assessment batteries for CAS. The Screening Test for Developmental Apraxia of Speech (Blakely, 1980), Kaufman speech praxis test for children (Kaufman, 1995), the Verbal Motor Production Assessment for Children (Hayden & Square-Storer, 1999), Dynamic Evaluation of

Motor Speech skill (Strand & McCauley, 2019), Madison Speech Assessment Protocol (MSAP) etc, are few to name. All these tests are developed in western context. Few tests for CAS which are developed in Indian context are Protocol for appraisal of verbal praxis in typically developing children for 2.0 – 4.0 years (Radhika & Manjula 2010), Protocol for appraisal of verbal praxis in typically developing children for 4.0 – 6.0 years (Gaganashree & Manjula, 2016) and language free assessment tool for childhood apraxia of speech in difficult to test population (Banumathy et al., 2012) etc.

Management of CAS

CAS is a condition with difficulty in planning and programming speech movements. Hence the treatment is focused on improving speech motor programming and execution, which will reduce the speech motor errors and increase communication effectiveness. Treatment can either follow a bottom up approach or a top down approach considering the severity of the problem behaviour. According to bottom up approach, the stimuli chosen for treatment should initiate from the current status of the child and should follow simple to complex hierarchy (simple motor speech pattern with visible sounds to complex motor speech pattern), keeping in mind the phonemic and phonetic repertoire etc. For example, for a child who is nonverbal, the treatment can start with imitation of movements followed by imitation of phonemes, syllables, sequencing syllables into words of varied syllable structure, self monitoring etc. Whereas, in top down approach, therapy needs to be initiated using complex stimuli and then followed by simple stimuli. Both these approaches are used in the treatment of children with speech sound disorders. Treatment approaches or techniques for CAS employ bottom up approach like DTTC (Strand, 2019), NDP3 (Williams & Stephens, 2004), ReST (Ballard et al., 2010), phonotactic therapy (Velleman, 2002) etc.

Treatment techniques employing top down approach have been used in treating population with phonological impairment. Though CAS is reported to involve phonological component as well, evidences for use of this approach and its benefits in treatment of CAS have not been documented in the literature.

There are many principles for motor learning which when included in the treatment, results in maximizing motor learning and generalisation. These principles can be broadly grouped into two categories, one based on structure of practice [Amount (small/less number of practice trials versus large number of practice trials), distribution (Massed practice, that is practicing a given number of trials over small period of time versus distributed practice, that is, practicing given number of trials over a longer period of time), variability (Constant, that is, practicing same target preferably in same context like only in initial position, versus variable, that is, practicing various targets in different context), schedule (Blocked, that is, different targets are practiced as separate, successive blocks or one after the other, versus random, that is practicing different targets in the same session or simultaneously), attentional focus (Internal focus on bodily movements versus external focus on effects of movements) and target complexity (simple, easy acquired sounds and sequences practiced earlier versus complex, later acquired sounds and sequences practiced earlier)] and another based on the nature of feedback [Type (Knowledge of Performance, that how a sound/word was produced, explanation of movements etc, & knowledge of results, that is whether the production of sound/word was correct or not, how many trials was it correctly articulated), frequency (High, that is feedback after every trial & low, that is feedback after certain number of trials) and timing of feedback (Immediate following attempt of production versus delayed)].

The effect of these principles on motor learning has been investigated. Practice amount or treatment intensity has greatest evidence for speech of children with CAS, supporting that highest gain is observed for large number of practice trials and sessions within one block of treatment. Namasivayam et al., (2015) and Thomas et al., (2014) reported that two sessions a week was the minimum intensity that has been shown to work. Maas et al., (2019) conducted a single subject study with multiple baselines on four children with CAS to examine the effect of practice amount and distribution. They concluded that high practice amount and massed practice were effective compared to low practice amount and distributed practice, for children with CAS. Treatment utilizing blocked practice for children with CAS facilitates acquisition but not retention of the behaviour or generalisation (Knock et al., 2010). Reduced frequency of feedback and delayed feedback aided in better retention of learnt verbal skills and generalisation to other stimuli which are not targeted in treatment sessions for adults with apraxia of speech compared to high frequency and immediate feedback (Austermann-Hula etal., 2008). Advocating knowledge of performance (KP) helps in the initial stages of treatment of CAS for acquisition of new motor behaviour but knowledge of results (KR) helps in retention and generalisation of learnt motor behaviour (Maas et al., 2008). To summarize, to acquire a new skill, intense, constant and blocked practice along with high frequency, immediate feedback and knowledge of performance should be utilised during treatment. For retention of a skill, intense, random and variable practice along with low frequency, delayed feedback and knowledge of results must be utilised during treatment (Preston et al., n.d.).

There are different approaches such as motor based approach, linguistic approach and multimodality approach, which are used for children with CAS. Motor

programming approaches are based on motor learning principles. It emphasises on the need for multiple repetition or articulatory drill which helps child with CAS to produce the sound and sequencing these sounds accurately, consistently and spontaneously. Few of the techniques which are based on this approach include (1) Nuffield's Dyspraxia Programme (Williams & Stephens, 2004), (2) Rapid Syllable Transitions Treatment (Ballard et al., 2010), (3) Dynamic Temporal and Tactile Cueing (Strand, 2019), (4) Kaufman speech to language protocol (Kaufman, 2001), (5) PROMPT System (Prompts for Restructuring Oral Muscular Phonetic Targets) (Chumpelik, 1984), (6) Melodic Intonation Therapy (Helfrich-Miller, 1994) etc. Linguistic approaches focus on the phonology, semantics and syntax of a language. These approaches include phonological awareness intervention techniques. Some children with CAS show difficulty in phonological processing or in phonological awareness tasks consequently leading to difficulty with literacy skills. Phonological awareness activities also help children to sequence phonemes into longer linguistic units. Few of the linguistic approaches which are used for treatment of CAS includes (1) Integrated Phonological Awareness Approach (Gillon & McNeil, 2007), (2) Phonotactic therapy (Velleman, 2002) etc.

Motor programming approaches

1. **Nuffield Dyspraxia Program – 3 (Williams & Stephens, 2004)**

Williams & Stephens, designed a bottom-up treatment approach based on motor programming skills, primarily for children aged 3-7 years. It is an evidence-based approach used with children with CAS and those with severe speech sound disorders. It is a multi level, multi target treatment approach, starting with isolated speech sounds (like consonants and vowels) and followed by CV, CVCV, CVC

words, multisyllabic words, consonant cluster words, phrases and sentences and finally connected speech. It also includes activities, tasks and games involving phonological awareness skills. Speech sounds are established by associating them with pictures.

Williams & Stephens reported six descriptive case studies in their therapy manual of NDP3. Children in the age range of 4-12 years were recruited for the study. Overall results revealed that all the children were able to speak with good intelligibility, but, the duration and quantity of therapy they underwent varied. Among the 6 cases, two case studies have been described below.

A 5 year old child diagnosed with moderate developmental verbal dyspraxia with oro-motor component, underwent blocked, 20 weekly therapy sessions. Post-treatment, the phonetic inventory of the child had expanded and included five new consonants. Speech rhythm improved and had good speech intelligibility by the end of the treatment. Response generalisation to untreated words was observed.

A 3-year-old child diagnosed with severe oral and verbal dyspraxia with possible mild dysarthric element underwent two 20-minute sessions on a daily basis. Single sounds and CV syllables were targeted in the first year of treatment along with oromotor skills targeting oral postures for vowels. By the end of first year, the child was speaking in short sentences but had poor speech intelligibility. CVCV and CVC words were targeted during the second year of treatment along with segmentation and blending of CVC words, vowel discrimination and simple onset/rime tasks. Simple multisyllabic words and short phrases were targeted at the end of second year. Sequencing single sounds, words, multisyllabic words, consonant cluster words and sentence level were worked on in the third year of treatment. After 3 years of

treatment, phonological skills were more or less accurate but speech was still unclear due to poor vocal control and inadequate airflow and limited range of tongue movement.

A case study was conducted on a 3 year old child diagnosed as autism spectrum disorder with developmental verbal dyspraxia. NDP3 was administered in once weekly therapy sessions. Significant improvement in expressive vocabulary was observed after 3 months of therapy along with mean length of utterance, which improved to 3 words. The child was able to speak in 5–6 word sentences after 6months of therapy with significant improvement in expressive vocabulary. (Saunders, 2006, as cited in https://www.ndp3.org/evidence-base/)

2. Rapid Syllable Transition Training (Ballard et al., 2010)

It is an evidence based treatment approach incorporating principles of motor learning. It avoids real linguistic forms and uses pseudowords for treatment. Evidences have shown that real words also improved due to response generalisation. It is carried out in 4 steps. First step is to decide if a particular child can have best benefits from ReST. Child should be able to produce atleast 4 syllable initial consonants and 4 vowels to initiate ReST treatment. Second step is to determine the goals, plan treatment sessions and prepare for therapy. 20 nonsense/pseudowords have to be prepared which has to be taught in 12 sessions. Therapy materials, tokens and materials for cueing have to be prepared before the session. Third step is the training phase. Here, concept of sound (the accuracy of phoneme production), beat (refers to linguistic stress and rhythm in a word) and smoothness (refers to transition from one sound to next sound) are worked on using the nonsense words. Clinician is advised to provide feedback for every attempt in this phase along with knowledge of

performance. Third phase is suggested to be carried out for about 5-10 minutes, after which one can move to next step, that is, practice phase, when child correctly produces or imitates the adult production, with prosody, for five times. In the final phase, clinician should provide knowledge of results and provide feedback for about 50% of the time (McCabe et al., 2017).

Scarcella et al., (2021) conducted a pilot study to understand the effects of ReST on Italian children. The treatment procedure used in English were replicated and modified based on Italian language. Italian use 3 stress patterns commonly, whereas, 2 stress patterns are used commonly in English. Two monolingual Italian speaking children diagnosed with childhood apraxia of speech, were recruited for the study. Twelve, 1 hour session were provided 2-3 times a week. Accuracy of sound produced, lexical stress and smoothness were assessed pre-treatment, 1 day, 1 week and 4 months post-treatment. Results revealed that both the children showed improvement on treated pseudoword and real words. Only one child generalised to untreated pseudowords. Both the children had maintenance of treatment.

Thomas et al., (2018) studied the treatment outcomes and fidelity of combined clinician – parent delivery of ReST treatment. Six clinic-based sessions (which were video recorded) and six home-based sessions (only audio recorded) were provided, to 5 children in the age group of 5.1 – 7.11 years with the diagnosis of CAS. They were assessed for acquisition of treated pseudowords, untreated pseudowords, untreated real words and parent & clinician treatment fidelity and reliability of perceptual judgements. Researchers concluded that combined clinician – parent delivery of treatment was less effective and that multiple factors affect the treatment outcome.

Thomas et al., (2016) studied the efficacy of ReST treatment delivered through telemode and compared with face to face ReST treatment delivery. Five children in the age group of 5 – 11years diagnosed with CAS underwent ReST treatment for 3 weeks (4 times per week) through video conference. They were analysed for imitation of pseudowords, generalisation to untreated pseudowords & real words and for maintenance of the skills. Results revealed that all the children demonstrated significant improvement in imitation of pseudowords and generalisation to untreated similar pseudowords and real words. Imitation of phrases with trained items was also observed in 2 children. 4 children showed maintenance of acquired skills upto four months post treatment. Researchers concluded that teleservice of ReST treatment was effective.

Murray et al., (2015) conducted a randomised control trial comparing two treatment approaches for CAS, that is, Nuffield Dyspraxia Program – 3 and Rapid Syllable Transition Training. Twenty-four children with CAS in the age range of 4 – 12 years were recruited and randomly assigned to group undergoing either NDP3 or ReST treatment. Therapy was provided for an hour in a day and four days per week for 3 weeks. Results revealed that all the children showed large treatment gains and significant generalisation effects were present irrespective of treatment they received. Immediate effect was better seen for NDP3 and long term effect was better observed for ReST treatment. NDP3 and ReST are considered as current gold standard treatments for CAS. (McCabe et al., 2019). Only these two treatment techniques have RCT level of evidence.

3. Dynamic Temporal and Tactile Cueing (DTTC) (Strand, 2019)

It is a motor based treatment approach (initially referred to as integral stimulation approach) for young children with moderate – severe CAS, whose goal is to improve neural processing efficacy for development and fine tuning of movements. The focus of the treatment is to teach the speech movement gesture and not individual sounds. Joint attention and intent to communication are prerequisites for implementing DTTC approach to any child with CAS. This approach does not have a predefined set of target stimulus or any picture cards. Clinicians should determine the speech gestures and then have to select target words which are relevant to the predetermined speech gestures. Initially, simultaneous production of target word is encouraged, followed by immediate repetition, repetition after delay and finally spontaneous production of target word. Multimodal cueing is also used in this approach.

A systematic review conducted by Murray et al., (2014) reported that DTTC is one of the three treatment methods with sufficient evidence for clinical practice. Strand et al., (2006) carried out a case study (single subject, multiple baseline design) and replicated on four children. All four children recruited for the study were diagnosed with CAS and did not have hearing impairment or severe cognitive impairment or autism spectrum disorder. They received two 30 minutes session per day, however total number of therapy sessions varied between 43 – 50 sessions over 4 – 6 week period. DTTC approach was administered. A stimulus set of 5 - 6 functional utterances were taken as target and each item was practiced for 15 – 30 times and then another utterance was taken up as target word. Out of four children, three children showed significant improvement shortly after the implementation of treatment. Two

children moved onto generalisation phase and were able to demonstrate good maintenance across time.

4. Kaufman speech to language protocol (Kaufman, 2001)

It is developed based on motor learning principles and applies behavioural analysis strategies. It focuses on the child's speech motor skills, and utilising successive approximation and shaping technique, the phonetic and phonotactic repertoires of the child are shaped towards higher speech motor coordination levels. K-SLP aims to teach the target words using developmentally sequenced phonological processes (like segregation of vowels in diphthongs, epenthesis), simplifying speech motor planning. It does not aim to match the adult form, but instead tries to match the target form.

There is very limited evidence for its use in CAS population. Gomez et al., (2018) conducted a pilot study on two individuals with severe CAS in the age group of 4-6 years. Ten preselected words (C1V1C2V2), ten simple polysyllabic words and ten functional words which were not in child's expressive vocabulary were selected as target words. Each individual had different set of words. One child had additional ten phrases as target. Each individual underwent 4 hour treatment per week for three weeks. The responses were recorded and compared across three timelines, baseline, treatment and post-treatment. Results revealed that both individuals showed some improvement in percentage phoneme correct and one individual showed minimal generalisation to untrained similar word.

5. **PROMPT System (Prompts for Restructuring Oral Muscular Phonetic Targets) (Chumpelik, 1984)**

It is a tactile kinesthetic approach in which, clinician provides tactile cues for the position and movement of articulators like jaw, lip, tongue and vocal folds (for voicing cues). It not only considers the speech production aspects, but also incorporates cognitive-linguistic and social emotional aspects of speech. It links auditory tactile motor map with the cognitive linguistic concepts.

Dale & Hayden (2013) conducted a study on four children (age range: 3.6 to 4.8 years) with CAS. Children were randomly placed in two groups. Each child attended 2 sessions per week for eight weeks. One group of children received 16 sessions of full PROMPT therapy with tactile, kinesthetic and proprioceptive cues and the other group received 8 sessions of full PROMPT with tactile, kinesthetic and proprioceptive cues and 8 sessions of PROMPT without tactile, kinesthetic and proprioceptive cues. Significant gains were observed for all four children, but children who underwent full PROMPT had relatively higher gains on motor speech control domain and generalisation to untreated probes.

6. **Melodic Intonation Therapy (Helfrich-Miller 1994)**

The technique is used to improve expression of speech using natural prosody of language or singsong pattern. Its usage in persons with aphasia has been well documented in literature. Effects of use of MIT in apraxia, especially CAS, are an upcoming field. Inner rehearsal or silent intoning of target word or phrase or sentence helps in sequencing the motor commands correctly (Norton et al., 2009).

Martikainen & Korpilahti (2011) performed a single case study to examine the effects of combination of two approaches (MIT and Touch Cue Method) on a 4.7 year

old child diagnosed with CAS. Child underwent MIT therapy for 18 sessions in six weeks (each session of 30 minutes) followed by no treatment phase for six weeks and again 18 sessions of touch cue method (TCM) approach in six weeks. The child showed significant gains in percentage of consonants correct (PCC), percentage of vowels correct (PVC) and phonological mean length of utterance (PMLU) during treatment phase and was maintained during twelfth week follow up. PVC improved during MIT treatment phase and continued to improve till the TCM phase whereas PCC and PMLU gains were observed after MIT phase that is from no treatment phase and continued till TCM phase. Authors concluded that the combination of MIT and TCM was effective for the treatment of CAS.

Linguistic based approaches

1. **Integrated Phonological Awareness Approach** (Gillon & McNeill, 2007)

It is a linguistic based approach for preschool children with speech and language impairment and not specific for CAS. It facilitates speech production and phonological skills. It also incorporates increased practice trials and feedback to aid speech production. This approach is regarded as a promising method for working on speech, phonological awareness, and letter knowledge simultaneously, as reported by Moriarty & Gillon (2006).

Hume et al., (2018) provided 30 sessions of traditional articulation treatment along with IPA approach to six children with CAS in the age range of 4.9 – 7.3 years, and compared pre and post intervention assessments. They found significant improvement in accuracy of phoneme production, consistency in word production and phonological awareness skills.

McNeill et al., (2009a) administered controlled multiple single subject design on twelve children in the age group of 4 – 7 years diagnosed with CAS. They underwent IPA intervention for six weeks (two sessions per week), followed by six-week withdrawal block and another six-week intervention block (two sessions per week). Authors reported that 9 children with CAS showed significant improvement in targeted speech sound production and transfer of atleast one targeted sound to connected speech. Eight children with CAS showed significant gain in one target phoneme awareness skill and transfer to novel phoneme awareness task. Children demonstrated improvement in phonological skills.

McNeill et al., (2009b) carried out a study on a pair of identical twins, who were diagnosed to have CAS at the age of 3.9years. Both underwent treatment with IPA approach for four months. Assessments were carried out at different timelines that is, pre intervention, post intervention, 6 months post intervention and 1 year post intervention. Both showed marked improvement in accurate production of vowels and consonants, phonological skills and decrement was observed in inconsistent production.

Moriarty & Gillon (2006) conducted a multiple single subject design on three children aged between 6.3 – 7.3 years, who received seven hours (approximately) of IPA treatment and reported that all the children showed improvement in both speech production and phonological awareness skills domain and only two children showed significant gains post-treatment in both the domains.

2. Phonotactic therapy (Velleman, 2002)

It is a therapy approach which focuses on establishing a particular phonotactic structure rather than the accurate production of segments unlike other treatment

strategies which focus on production of segmental accuracy. It employs bottom up approach wherein word structures are taught from simple to complex. The goals formulated are also based on the phonological process that is affected. Velleman has proposed the hierarchy of phonotactic pattern, starting with simple open syllables (CV), reduplicated open syllables (CVCV -- same syllable repeated as in "bye-bye"), harmonized (C or V) non-reduplicated disyllabic open syllable forms (CVCV), non-harmonized non-reduplicated disyllabic open syllable forms, harmonized closed syllables, non-harmonized closed syllables, CVCVC words (reduplicated, harmonized, or neither) and words with initial, medial, and/or final clusters. With respect to phonological processes, clinicians can work on CV structure if deletion of initial consonant is present, work on VC or CVC if deletion of final consonant is present, work on C1V1C2V2, C1VC2V, CV1CV2 to decrease harmony and reduplication, work on CVCV if child is simplifying multisyllabic words, and work on clusters in different position (initial/medial/final) if consonant cluster reduction is present. It makes use of modelling, adjacency, fading and syllable alterations by altering stress, harmony and pattern. Phonotactic goals proposed include (1) production of complete syllables, (2) production of closed syllables,(3) production of disyllables, (4) decreasing reduplication of harmony, (5) production of varied stress pattern within a word without omitting the unstressed syllable within the word, (6) sequencing phonemes of different place and/or manner and (7) production of consonant clusters (Velleman, 2006).

“Once the structures are established within the child’s phonology, it becomes reasonable to set a goal of accurate phonetic production within that structure, but not before” (Velleman, 2002).

A 3.4 year old child with severe unintelligible speech, normal receptive language skills but delayed expressive language skills, final consonant deletion and limited phonetic repertoire underwent 6 months of phonotactic therapy. Significant improvement in production of bisyllabic words was observed post treatment along with improvement in production of CVC words. When the child was reassessed after one year of interval with no treatment, child had profound phonological impairment with slight improvement in phonetic repertoire. The child again underwent 6 months of phonotactic therapy to improve his phonotactic repertoire. The severity reduced from profound to 'severe' phonological impairment, he was able to produce consonant clusters, final consonant deletion reduced and was able to self monitor speech, post treatment (Velleman, 2002).

The Nuffield Dyspraxia programme, an evidence based approach, which is most widely used by speech language therapists for treating CAS, the Kaufman speech praxis kit (Kaufman, 2001), and the Webber Mini apraxia photo cards (*Webber MINI Apraxia Photo Cards | Product Info*, n.d.) and Webber Big apraxia photo cards (*Webber BIG Apraxia Photo Cards | Product Info*, n.d.) considers the phonotactics of language and the stimuli are prepared in increasing phonotactic complexity. All these commercially available products for treatment of apraxia are evidence based.

Based on this information and the evidences provided by researchers for the use of phonotactic treatment of CAS, we can conclude that children with CAS benefit from speech therapy which incorporates phonotactic skills. Speech motor skills in CAS, improve when the phonotactic structure of a particular language is focused during the treatment. It also helps in improving articulatory transition from one phoneme to the next or the sequencing of phonemes, production of words, improve

phonological skills, expressive language skills etc, indirectly reducing the risk of the child to present with future complications such as difficulty in literacy skills. Hence it is important to focus on both phonetic as well as phonotactic skills during therapy for CAS.

To sum up, children with CAS demonstrate difficulty in production of phonemes, precisely the sequencing of phonemes, which can be due to underlying immature phonological processing. They exhibit both phonetic and phonotactic errors, which need to be targeted during treatment. Most of the treatment approaches are based on motor learning principles and employ bottom up approach. An indepth review of the existing literature revealed that children with CAS benefit from speech therapy when both phonetic and phonotactic skills are worked upon.

Treating CAS using phonotactic skills is language dependent as each language has its own phonotactic structures. Treatment packages available for CAS incorporating phonotactic skills are available in English and hence cannot be used with children of other language origins. This necessitates the need to develop treatment manual incorporating phonotactic skills in various languages. In view of this, the present study was designed with the aim of developing a manual for training phonotactic structure in Kannada speaking children with CAS which helps in working on and improving both phonetic and phonotactic skills.

CHAPTER III

METHOD

The present study aimed at developing a manual for training phonotactic structure in Kannada speaking children in the age range of 2-6years with CAS and validating the content of the manual. The study was conducted in following phases.

Phase I: Existing literature review

Phase II: Development of treatment manual

Phase III: Content validation of treatment manual

Phase I: Existing literature review

Information related to CAS, definition, etiological factors associated with CAS, prevalence studies related to CAS, characteristics and different treatment approaches related to the management of CAS was reviewed from various sources such as published books, research articles from journals, therapy manuals, web sources such as Google scholar, PubMed etc. and the same was compiled. The existing evidence-based treatment protocols were also reviewed. Further, treatment approaches incorporating phonotactic structure in particular, were also reviewed for better understanding of the effect of phonotactics in treatment of CAS, stimuli hierarchy (phonotactic hierarchy) and the type of activity to be incorporated, which aid phoneme sequencing abilities. Few of the key words used for the search were ‘childhood apraxia of speech’, ‘Developmental verbal dyspraxia’, ‘characteristics’, ‘phonotactics’, ‘therapy’, etc.

Phase II: Development of treatment manual

This phase involved the development of manual for training the phonotactic structure in Kannada and is applicable for children with the diagnosis of CAS. The phonetic and phonotactic structure in Kannada was studied in detail. Kannada is a syllabic language with the structures of CV, VC, CVC, CCVC, VCV, VCVCV, CVCCV etc. Both open and closed syllables are found in Kannada. However, the most frequently occurring are open disyllables word shapes, followed by trisyllables and multisyllables (Rupela & Manjula, 2006). Further, in Kannada, two vowels do not occur consecutively (Rajpurohit, 1975; Rupela &Manjula, 2007). It differs from English in some aspects. For example, CCCV structure is more common English when compared to Kannada. Words in English usually end with an open syllable, whereas in Kannada, closed syllables occurs at the final position of a word. In English, /h/ occurs only in initial position and /ŋ/ occurs only in the final position. Whereas in Kannada, /h/ can occur in both initial and medial position and /ŋ/ can occur in the medial position. Because of the differences that exist in the phonotactic structure of these languages, the permissible combination of phonemes in Kannada was studied and then words were selected accordingly.

The developmental acquisition of speech sounds in Kannada speaking children (Anand & Savithri, 2011), phonotactic hierarchy (Velleman, 2002), combined with that proposed by Williams & Stephens (2004), was adhered to, while developing the training material. The words were grouped into different levels based on the developmental acquisition of speech sounds in Kannada as shown below.

- Level 1: Bilabials /p/, /b/ and /m/
- Level 2: Alveolars /t̪/, /d̪/ and /n/

- Level 3: Velars /k/ and /g/
- Level 4: Labiodentals /v/ and alveolar /l/
- Level 5: Palatals (affricates) /tʃ/ and /dʒ/
- Level 6: Palatal (stops) /ʈ/, /ɖ/ and /ɳ/
- Level 7: Palatal (laterals) /r/, /ɭ/, palatal (fricative) /ʃ/, alveolar (fricative) /s/ and pharyngeal (fricative) /h/

Each level included particular phoneme at various phonotactic complexity and syllable sequence as follows:

1. **Isolated syllable repetition**
   a. Un-aspirated consonant + lax vowel, (eg: /pʌ/, /bI/, /mo/)
   b. Un-aspirated consonant + long vowel (eg: /pa:/, /bi:/, /mo:/
   c. Aspirated consonant + vowel (eg.: /p^hʌ/, /b^hI/)

   The syllables are placed such that the CV combination in which the vowel context better elicits the particular consonant is positioned earlier. For example, /dʒ/ is better elicited in context of /i/ and /u/ (Rao, 2018). Hence, /dʒu/ and /dʒI/ are placed before other vowel contexts such as /dʒa/, /dʒe/ and /dʒo/ in the manual. The facilitating vowel context for particular phoneme given by Rao (2018) was followed.

2. **Anticipating articulatory change in repeated phonetic sequences**
   a. Changes in last syllable only (eg.: /pa pa pa pa po/, /mu mu mu mu mo/
   b. Alternating syllable sequence (eg.: /pa po pa po/, /mu mo mu mo/) and
   c. Randomly alternating syllable sequence (eg.: /pa po po pa pu/, /mo mo mu mu me/)

3. Words

a. CVCV (e.g., /ma:ma/, /pi:pI/ etc)

b. CV1CV2 (eg: /pa:pu/, /ke:ku/ etc),

c. C1VC2V (e.g., /mu:gu/, /gIṇI/ etc),

d. C1V1C2V2 (e.g., /mane/, /ka:lu/ etc),

e. VCCV (e.g., /pennu/, /kallu/ etc.) and

f. CVCCV (e.g., /akka/, /Illa/ etc).

Only meaningful words and pseudowords used by toddlers were incorporated. In some levels, all the above mentioned phonotactic structures could not be incorporated as no meaningful word or pseudoword existed (with that particular word structure) in Kannada, which were familiar to children.

4. Play based activity

This subsection included play-based activities to target the production of words in a playful manner. For example, every time the child says /mammu/, cut-out of scoop of ice cream can be placed on cone. After 5-6 repetitions of the word, complete picture of ice cream will be connected and child can be reinforced with real ice cream. This has been depicted in the figure 3.1 below.

Figure 3.1: *Example of cut and paste play based activity.*

For training in the sequencing of phonemes, a few analogies such as bubble analogy, kite analogy, door analogies etc, have been incorporated. In the Bubble analogy for example, the child has to point to the small bubbles and say the associated sounds and finally say the target word pointing to the big bubble. These analogies are different from the play based activities, which are focussed on the production of the whole word, while these analogies help teach the concept of sequencing syllables to produce words. The figure below depicts the analogy.

Figure 3.2: *Example of analogy used for sequencing syllables to produce a word.*

A daily record form and a monthly record form were designed for easy documentation of a client's progress by the speech-language pathologist (SLP). This has been attached in the appendix II.

Each syllable and word is associated with particular picture. It acts as a cue for production of corresponding syllable or word. Most of the pictures/images used in the manual have creative commons licence, that is, a standardized way of permitting to use the creative works done by others under copyright law.

Phase III: Content validation of treatment manual

The content validity of the manual was assessed based on six parameters which were selected from the feedback questionnaire developed by Goswami et al., (2010) as part of field testing of MANAT-K. Google forms were prepared separately for validation of the format of the manual and the validation of each level (Reader is referred to appendix III for samples of the questinnaire for content validation). A total of eight Google forms were prepared. Four speech-language pathologists (SLPs) who had experience in the treatment of CAS and/or phonological disorders provided feedback on the questionnaire on the format of the manual. They also provided feedback on the syllables, words and associated pictures of level 1. The remaining levels, that is, level 2 – 7 (syllables, words and associated pictures) were assessed by three validators as the fourth validator could not provide the feedback within the allocated time. All the four SLPs were informed about the nature, purpose and procedure of the study and the consent was received prior to content validation. Google forms (with questionnaire) were mailed one at a time. Initially, Google form for format validation and Level 1 were mailed. Once the response was received, Google form of the next subsequent level was mailed. In this manner, the Google forms for all the levels were mailed one after the other. The Google form was mailed along with the PDF version of the manual.

For validating the format (depiction of syllables with long vowels, syllables with aspirated consonants, geminate, word production and hierarchy of subsections within each level), the SLPs were asked to rate the format as good or fair or poor, based on the parameters such as appropriateness, stimulability and trainability.

a. Appropriate: Are the analogies used appropriate?

b. Stimulability: Can the stimulus material elicit responses from the child?
c. Trainability: Can the stimuli be used for intervention purpose?

For validating the words and associated pictures in each level, the SLPs were asked to rate the word along with picture, based on different parameters like, familiarity, appropriateness, stimulability, trainability, likeability and colour and appearance as good, fair or poor.

a. Appropriate: Are the phonemes/syllables appropriately associated with the pictures?
b. Familiarity: Are the word and/or pictures familiar to even young children?
c. Colour & appearance: Are the picture stimuli appropriate in terms of colour?
d. Stimulability: Can the stimulus material elicit responses from the child?
e. Trainability: Can the stimuli be used for intervention purposes?
f. Likeability: Will children like the stimuli images?

In addition, a comment section was provided, where the SLPs could suggest any modification of the stimuli or any other suggestions, along with appropriate rationale for the same. The results of the study have been discussed in the next chapter.

CHAPTER IV

RESULTS

As a part of this study, the development and validation of a resource manual for training phonotactic structures in Kannada for children with CAS was undertaken. The findings of the study have been presented as two sections.

Section I: Development of the manual

Based on the phonotactic structure of Kannada and the developmental acquisition of sounds, the type of stimuli and their hierarchy, were arrived at and different training levels for different sounds were included in the manual. The manual had seven levels viz: Level 1: /p/, /b/ and /m/, Level 2: /t̪/, /d̪/ and /n/, Level 3: /k/ and /g/, Level 4: /v/ and /l/, Level 5: /tʃ/ and /dʒ/, Level 6: /ṭ/, /ḍ/ and /ṇ/ and Level 7: /r/, /ʃ/, /s/ and /h/. Each level has various subsections, the details of which have been provided below.

a. Fun with CV forms with consistency of consonant and lax vowel

In this section, each syllable was associated with a particular picture. The syllable along with the corresponding picture and its orthographic representation was provided five times in the manual to facilitate the repeated production of the target. The child is expected to point to each picture and produce the appropriate sound five times. For example, the stimulus /ma/ is associated with a picture of tree, since, in Kannada, tree is known as /mara/. The picture associated with a particular sound would act as a cue for production. Successive repetition of the sound would help in better acquisition of the sound and word forms.

ಮ

/ma/

Figure 4.1: *Example of CV forms with consistency of consonant and lax vowel.*

b. Fun with CV forms with consistency of consonant and long vowel

In this section, image of a scale or stick is used as a cue for teaching the concept of lengthening of the vowel. For example, if an image of scale is given below the picture of a tree (associated with sound /ma/), the child is expected to lengthen the vowel in CV form, by running the finger through the length of the scale. Short and long vowels in words can convey different connotations. In Kannada, for example, /d̲ara/ means cost and /d̲a:ra/ means thread. Hence, it is necessary that children with CAS are trained to produce appropriate length of the vowel.

ಬೀ

/bi:/

Figure 4.2: *Example of CV forms with consistency of consonant and long vowel.*

c. Fun with CV forms with consistency of aspirated consonant and vowel.

In this section, the way in which aspirated sound can be produced has been shown. Here, an animated picture of a cloud which is blowing air (as shown in the picture below) is presented beside the picture of the target syllable, cueing the child the presence of flow of air during the production of aspirated sounds.

However, this subsection is not included in level 4 and level 7, as the phonemes or consonants targeted in those levels do not have aspirated counterpart. Aspirated sounds are present in Kannada. Though, these are not used colloquially, this was included in the manual because, in some instances, it changes the meaning of the word (eg. /d̪ana means cow and d̪^{h}ana means wealth). Identifying and differentiating aspirated and unaspirated phonemes becomes necessary in the development of phonological skills and literacy skills.

ಫ

/p^{h}a/

Figure 4.3: *Example of CV forms with consistency of aspirated consonant and vowel.*

d. Anticipating articulatory change in repeated phonetic sequences

In this section, three subsections have been included which focuses on sequencing of phonemes. The three subsections are:

(1) Changes in last syllable only (eg: /pa pa pa pu/, /ba ba ba ma/ etc)

ಪಿ ಪಿ ಪಿ ಪಿ ಪೆ

/pI/ /pI/ /pI/ /pI/ /pe/

Figure 4.4: *Example of changes in last syllable only.*

(2) Alternating syllables (/pa pi pa pi/, /ma mu ma mu/ etc) and

Figure 4.5: *Example of alternating syllables.*

(3) Randomly alternating syllables (eg: /pa pu pa pe/, /ba be be pa/ etc).

Figure 4.6: *Example of randomly alternating syllables.*

Sequencing of syllables in this section may lead to production of either meaningful or nonsense words, but improves the phonotactic skills. These subsections are placed in simple to complex hierarchy. It is known that children with CAS have difficulty in transition from one phoneme to the next, and the difficulty increases as greater changes in articulatory gestures take place. Hence in the initial subsection, articulatory gesture changes for the last syllable only. In the next subsection articulatory gesture, changes alternatively (which is difficult to perform when compared to 'changes in last syllable only'). Finally, in randomly alternating syllables, articulatory gesture changes occur randomly and more frequently, which is more difficult when compared to previous other subsections.

e. Words

In this section, syllables are sequenced in a manner such that it forms a meaningful word. Different phonotactic structures are targeted in this section namely

(1) Harmonised CVCV

ಪೀಪಿ

/pi:pi/

Figure 4.7: *Pictorial and orthographic representation of harmonised CVCV.*

(2) CV1CV2

ಪಾಪು

/pa:pu/

Figure 4.8: *Pictorial and orthographic representation of CV1CV2.*

(3) C1VC2V

ಕಸ

/kasa/

Figure 4.9: *Pictorial and orthographic representation of harmonised C1VC2V.*

(4) C1V1C2V2

ಗೂಬೆ
/gu:be/

Figure 4.10: *Pictorial and orthographic representation of harmonised C1V1C2V2.*

(5) VCCV

ಅಪ್ಪ
/appa/

Figure 4.11: *Pictorial and orthographic representation of harmonised VCCV.*

(6) CVCCV

ಕೆಮ್ಮು
/kemmu/

Figure 4.12: *Pictorial and orthographic representation of harmonised CVCCV.*

It should be noted that some word structures are not included in few levels as words with that structure, which are familiar to younger children, were either not found or could not be represented pictorially. For example, in level 1, C1VC2V and C1V1C2V2 structures have not been included, as meaningful words with these structures, with only /p/, /b/ and /m/ phonemes, do not exist in Kannada.

f. Play based activity

In this section playful activities such as cut and paste name the missing item, spin a wheel etc. were included to elicit the words targeted in that particular level and the previous levels. The play-based activities/games are used to make the therapy sessions playful and interesting for the child.

To sum, the manual contains seven levels which includes 95 syllables and 119 words associated with pictures. This has been depicted in table 4.1.

Table 4.1

Combination of consonant and vowel in each level

Level / Vowel	1	2	3	4	5	6	7
/a/	/p, b, m/	/t̲, d̲, n/	/k, g/	/v, l/	/tʃ, dʒ/	/ṭ, ḍ, ṇ/	/r, l̤, ʃ, s, h/
/I/	/p, b, m/	/t̲, d̲, n/	/k, g/	/v, l/	/tʃ, dʒ/	/ṭ, ḍ, ṇ/	/r, l̤, ʃ, s, h/
/u/	/p, b, m/	/t̲, d̲, n/	/k, g/	/v, l/	/tʃ, dʒ/	/ṭ, ḍ, ṇ/	/r, l̤, ʃ, s, h/
/e/	/p, b, m/	/t̲, d̲, n/	/k, g/	/l/	/tʃ, dʒ/	/ṭ, ḍ, ṇ/	/r, l̤, ʃ, s, h/
/o/	/p, b, m/	/t̲, d̲, n/	/k, g/	/l/	/tʃ, dʒ/	/ṭ, ḍ/	/r, ʃ, s/
Total syllables	15	15	10	8	10	14	23

Additional words with the targeted word structure, without associated pictures, have been given after the corresponding subsection for further practice. Activities for production of syllables with aspirated consonants and those with long vowel context have been described.

Analogies such as door analogy, kite analogy, bubble analogy etc, have been included in the manual. These analogies assist the child in sequencing the phonemes/syllables in a particular order so as to produce the target word. Not all children find it easy to sequence sounds to form words. Particularly, the younger children may have difficulty with it. Hence these analogies have been provided. The

analogy appropriate for a particular child can be selected depending on the child's interest and understanding.

Section II: Content validation of treatment manual

The manual developed was given to SLPs experienced in the assessment and treatment of CAS and/or phonological disorder for content validation. Judges rated the format of the manual and various levels separately. The picture was modified or the stimulus was deleted, only if two judges rated a particular picture (associated with the word) or word, as poor on any one of the parameter. The results of the validation have been described under different heads.

Format validation

Four SLPs provided feedback on the overall organization within each level. The depiction of long vowels, aspirated sounds, words and geminates were rated. They also rated the arrangement of the subsections based on complexity. The responses of judges are summarised in table 4.2

Table 4.2

Responses of judges to format validation

Format	Appropriateness			Stimulability			Trainability		
	Good	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**
Depiction of long vowels	2	2	-	2	2	-	3	1	-
Depiction of aspirated sounds	3	1	-	4	-	-	4	-	-
Depiction of word production	3	1	-	4	-	-	4	-	-
Depiction of Geminates	2	1	1	2	2	-	2	2	-

On the parameter on appropriateness, three validators rated the depiction of aspirated sounds and word production as good and one validator rated it as fair. Two validators rated the depiction of long vowels as good and two validators rated it as fair. Two validators rated depiction of geminates as good, one rated it as fair and one rated it as poor. For stimulability parameter, all the four validators rated depiction of aspirated sounds and word production as good. For depiction of vowels and geminates, half of them rated it as good and the other half rated it as fair. With respect to trainability, all four validators rated depiction of aspirated sounds and word production as good. Depiction of long vowels was rated as having good trainability by three validators and as fair by one validator. Depiction of geminates was rated as good and fair equally.

Though the validators rated the format as fair to good, few suggestions were provided by them. The suggestions have been consolidated in the table 3 along with the modifications made. Some of the suggestions were incorporated, while others could not be incorporated, the rationale of which has been provided in table 4.3.

Table 4.3

Summary of suggestions provided and modifications incorporated

Sl.No.	Suggestions/Comments	Modifications/Responses
1	Maintain uniformity in the type of pictures used	The pictures for the manual were selected based on two criteria. (1) Appropriate for children (2) Have creative commons licence. Most of the pictures which were used in the manual had creative commons licence. A further attempt was made to maintain the uniformity.
2	Not convinced with using the same picture for CV forms to represent short and long vowels.	Since Kannada has almost 32 consonants, having a picture for every long and short vowel would make the manual very extensive. Also, finding words separately for each of these syllables (C+short vowel and C+long vowel), which are familiar for the age considered, would be difficult. Hence the use of analogy was thought of for discriminating between the long and short vowels.
3	Addition analogy used for depicting words may not be comprehensible for younger	The analogy of addition is only used as cue for the child to sequence the sounds and to aid in the production of words. Considering the

	children and violates semanticity of the concept.	suggestion, other analogies were provided such as bubble analogy, kite analogy, door analogy etc. Clinician can choose the appropriate analogy for the child.
4	Same picture can be given twice one after the other for depiction of geminates.	Since each picture is associated with a particular sound, there are possibilities that children may say same sound twice rather than producing it as a geminate if same picture was repeated twice adjacently. Hence this suggestion was not incorporated.
5	Aspiration should come at the end keeping the simple to complex hierarchy for subsections in the level.	Aspirated sounds were shifted after all the other syllables targeted in a particular level, but before word level, so that even aspirated sounds can also be trained in the subsections that follow (like sequencing sounds, word).

Validation of each level

a. Fun with CV forms

Each picture representing the CV syllable was assessed on six parameters (Familiarity, Appropriateness, stimulability, trainability, color & appearance and likeability) by the validators. A total of 95 syllables were included in the manual with the corresponding pictures. Level 1 was validated by four judges and level 2 – 7 were validated by three judges.

One picture in each level 1 and level 2 required modification based on the validator's feedback. One more stimuli in level 1 was modified as the picture associated, overlapped with another stimulus. None of the pictures representing

the syllables were removed or added based on the feedback received from judges. The modifications recommended were incorporated and a positive response was received from all the validators when the revised training material was sent to them again. The feedback and comments were received through mail.

b. Words

Level 1 was validated by four judges and level 2 – 7 were validated by three judges. Each word and the picture representing the words was assessed on six parameters, viz. Familiarity, Appropriateness, stimulability, trainability, color & appearance and likeability by the validators.

Pictures were modified only if any two validators rated atleast one of the six parameters (Familiarity, Appropriateness, stimulability & trainability, color & appearance and likeability of pictures associated) as poor. Words were deleted if any two validators rated atleast one of the four parameters (Familiarity, Appropriateness, stimulability & trainability of words) as poor. The modifications carried out post validation have been summarised in the table 4.4.

Table 4.4

Number of words deleted and pictures modified based on feedback from judges.

Level	**CVCV**			**CV1CV2**			**C1VC2V**			**C1V1C2V2**			**VCCV**			**CVCCV**			**Total**
	O	**M**	**D**	**O**	**M**	**D**	**O**	**M**	**D**	**O**	**M**	**D**	**O**	**M**	**D**	**O**	**M**	**D**	
1	3	2	-	3	-	1	0	-	-	0	-	-	3	-	-	3	-	2	**9**
2	3	-	1	0	-	-	0	-	-	3	-	-	3	-	-	3	-	-	**11**
3	3	-	2	3	-	1	3	-	-	3	-	-	3	-	-	5	-	-	**17**
4	0	-	-	3	-	2	4	-	1	4	-	1	3	-	-	3	-	1	**12**
5	4	-	1	4	-	3	6	-	1	4	-	-	3	-	-	3	1	-	**19**
6	3	-	1	2	-	-	4	-	-	5	-	-	0	-	-	4	-	-	**17**
7	2	-	2	3	2	-	4	-	1	4	-	-	0	-	-	3	-	-	**13**
Total	**18**	**2**	**7**	**18**	**2**	**7**	**21**	**-**	**3**	**23**	**-**	**1**	**15**	**-**	**-**	**24**	**1**	**2**	
Total words post validation		**11**			**11**			**18**			**22**			**15**			**22**		

Note: O = Number of words prevalidation; M = Number of pictures modified; D = Number of words deleted.

As depicted in the table, the following were the changes incorporated:

With respect to each levels,

i) **Level 1:** Picture associated with two harmonised CVCV words was modified, one CV1CV2 word was deleted and two CVCCV words were deleted based on the feedback of judges. Pre validation, level 1 consisted of twelve words in total and was reduced to nine words post validation.

ii) L**evel 2**: Only one harmonised CVCV word was deleted. No other stimuli was removed or modified. Pre validation, level 2 consisted of twelve words in total and was reduced to eleven words, post validation.

iii) L**evel 3**: Two harmonised CVCV words were deleted and one CV1CV2 word was deleted. Pre validation, level 3 consisted of twenty words in total and was reduced to seventeen words, post validation.

iv) L**evel 4**: Two CV1CV2 words and one in each C1VC2V, C1V1C2V2 & CVCCV words were deleted. Pre validation, level 4 consisted of seventeen words in total and was reduced to twelve words, post validation.

v) L**evel 5**: One harmonised CVCV word, three CV1CV2 words and one C1VC2V word were deleted. One picture associated with CVCCV word was modified. Pre validation, level 5 consisted of twenty-four words in total and was reduced to nineteen words, post validation.

vi) L**evel 6**: Only one harmonised CVCV word was deleted. No other words were modified or deleted. Pre validation, level 6 consisted of eighteen words in total and was reduced to seventeen words, post validation.

vii) L**evel 7**: Two harmonised CVCV and one C1VC2V words were deleted. Two pictures associated with CV1CV2 words were modified. Pre

validation, level 3 consisted of sixteen in total and was reduced to thirteen words, post validation.

With respect to the word structure,

i) **Harmonised CVCV:** A total of 7 harmonised CVCV words were deleted and two pictures associated with CVCV words were modified. Pre validation, harmonised CVCV words were 18 in number and was reduced to 11 words, post validation.

ii) **CV1CV2:** Similar to harmonised CVCV words, a total of 7 CV1CV2 words were deleted and two pictures associated with CVCV words were modified. Pre validation, CV1CV2 words were 18 in number and were reduced to 11 words, post validation.

iii) **C1VC2V:** Totally only 3 C1VC2V words were deleted. No other C1VC2V words were modified or added to the list. Pre validation, C1VC2V words were 21 in number and were reduced to 18 words, post validation.

iv) **C1V1C2V2:** Only one C1V1C2V2 word was deleted. No other C1VC2V words were modified or added to the list. Pre validation, C1V1C2V2 words were 23 in number and were reduced to 22 words, post validation.

v) **VCCV:** No modifications or additions or deletions of VCCV words were done as all 15 VCCV words were accepted by the validators. The number of VCCV words remained same from both pre-validation to post validation.

vi) **CVCCV:** A total of 3 harmonised CVCCV words were deleted and one picture associated with CVCV word was modified. Pre validation,

CVCCV words were 24 in number and were reduced to 22 words, post validation.

Majority of the pictures which were deleted and /or modified were real pictures of children or persons associated with proper nouns. Some of the comments made by the validators were (1) non meaningful word, (2) not commonly used word, (3) not a Kannada word, (4) it's a Hindi word, (5) it's a fiction word, (6) not used by many children, (7) inappropriate word, (8) it would be inappropriate to train the names with reference to real pictures of children and child may generalize them and (9) proper nouns like names cannot be used as generic terms. All the comments were accepted and the corresponding pictures were deleted. However one stimulus was retained which was associated with a proper noun, as it was a common word used by many adults with their kids, but the picture was modified by replacing a real picture with the animated one. Other stimuli were only modified with respect to pictures associated as the target words were appropriate and familiar for children.

All the modifications and deletions which were made in the manual were mailed to all the validators for feedback. The modifications and deletions made were accepted by all the validators.

c. Play based activity

Each level consisted of two different play based activities. All the play based activities were rated on four different parameters, (appropriate, stimulability, colour & appearance and likeability) by the validators. Play based activity given in level 1 was validated by 4 SLPs those given in level 2 – 7 were

validated by 3 SLPs. A total of 22 responses for each parameter were received. The responses have been summarised in the table 4.5.

Table 4.5

Responses of judges to validation of play based activities.

Levels	**Appropriateness**			**Colour & appearance**			**Stimulability**			**Likeability**		
	Good	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**
Level 1	2	2	-	3	1	-	4	-	-	3	1	-
Level 2	3	-	-	3	-	-	3	-	-	3	-	-
Level 3	1	2	-	3	-	-	2	1	-	1	2	-
Level 4	3	-	-	3	-	-	3	-	-	3	-	-
Level 5	2	1	-	3	-	-	3	-	-	3	-	-
Level 6	3	-	-	3	-	-	3	-	-	2	1	-
Level 7	3	-	-	3	-	-	3	-	-	3	-	-
Total	17	5	-	21	1	-	21	1	-	18	2	-
Percentage (Total/22)	77.27	22.72	0	95.45	4.54	0	95.45	4.54	0	81.82	9.09	-

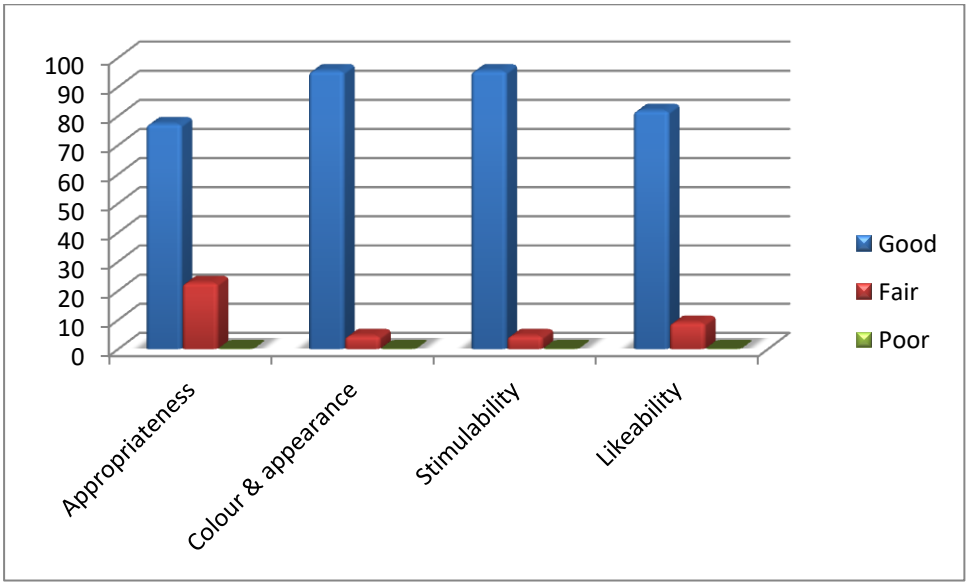

Figure 4.13**:** *Percentage of ratings received for each parameter on validation of words and associated pictures.*

For appropriateness of play based activities, out of 22 ratings 71.21% were rated good and 22.72% were rated fair. For stimulability and colour & appearance, 95.45% were rated good and 4.54% rated it as fair. Validators rated the play based activities as to 81.82% good and 9.09% fair. None of the validators rated the play-based activities as poor on any parameters.

To sum, the outcome of the study was a manual for training phonotactic structure in Kannada for children with CAS in the age range of 2 – 6 years. Based on the feedback from the experts, the stimuli had fair to good (predominantly good) appropriateness, familirity, stimulability, trainability, likeability. The color and appearance of images selected were rated as fair to good. The manual followed simple to complex hierarchy. All the play based activities were rated as predominantly good on the parameters appropriateness, stimulability, likeability and color & appearance. Few suggestions were provided for stimuli and pictures associated so that the stimuli presented could be improvised to elicit better response from the child. Minimum of one poor rating on any of the parameter by at least two validators was set as criteria for modifying the stimuli. Based on the feedback received, the manual was revised by modifying the stimuli accordingly. The modifications made were again sent to the validators for feedback. All the validators accepted the modifications made. Overall, the revised manual was rated to have predominantly good content validity based on all the parameters such as familiarity, trainability, stimulability, appropriateness, likeability and color and appearance of the stimuli. The results have been discussed in the next chapter.

CHAPTER V

DISCUSSION

The aim of the present study was to develop a manual to teach phonotactic structures of Kannada for children with CAS. The initial step towards development of manual began from compilation of data regarding the difficulties faced by children with CAS, treatment approaches and packages/protocols available for training phonotactics and reviewing these. The next step was to develop a stimuli list based on the phonotactic structure of Kannada along with looking for appropriate pictures to associate with the target syllable or word. It was challenging to search for meaningful words with particular phonotactic structure and limited or restricted phonemes. Another challenging task was to search for images which are appropriate for the word and the ones which had creative commons licence. Once the manual was developed, its content was validated by SLPs.

The present manual consists of seven levels, with each level focusing on particular phonemes. Level 1 focuses on /p/, /b/ and /m/, level 2 focuses on /t̪/, /d̪/ and /n/, level focuses on /k/ and /g/, level 4 focuses on /v/and /l/, level 5 focuses on /tʃ/ and /dʒ/, level 6 focuses on /ʈ/, /ɖ/ and /ɳ/ and level 7 focuses on /r/, /ɭ/, /ʃ/, /s/ and /h/. These levels are arranged in the order of developmental acquisition of speech sounds in Kannada. Each level consists of several sections focusing on syllables (to improve phonetic repertoire), sequencing of sounds (to develop and maintain smooth transition from one sound to the other, reducing dysprosodic features like inappropriate pauses within words and to broaden the phonotactic repertoire) and words (to improve expressive vocabulary, phonotactic and phonological skills) which are placed in simple to complex hierarchy. Each syllable and word is associated with particular image, which acts as a cue for production of syllables and words. It provides activities

for sequencing of sounds and word production. Play based activities are also included so as to retain child's attention and encouraging playful learning process. The manual comes with daily and monthly record form which helps to track the individual's progress in therapy.

The manual is unique in its own way, aiming to broaden phonetic and phonotactic skills simultaneously in children with CAS. Broadening phonetic repertoire helps in accurate production of speech sounds and helps in the production of new words within the available phonotactic frame. Broadening phonotactic skills helps individual to produce both simple and complex words of various word structures, helping in faster learning of word production, reducing the phonological processes used to simplify words and to acquire adult like speech skills. Working on both phonetics and phonotactics also helps in improving speech intelligibility and naturalness. It makes use of motor learning principles in combination with phonotactic therapy principles to improve verbal language skills of children with CAS. It uses colourful pictures associated with syllables and words, provides few analogies and activities to help phoneme sequencing abilities. Available evidence based approaches have shown that, targeting phonotactics in children with CAS has shown to improve their expressive language abilities, reducing the severity of the impairment and its effect on individual's life. It is assumed that this manual will also help in the phonetic and phonotactic development of individual with CAS, overcoming the planning and programming difficulties of speech movements and aid in betterment of quality of life of individual with CAS.

The manual developed is similar to other evidence-based practices like that given by Williams & Stephens (2004) as it uses pictures associated with phonemes, syllables and words for treating CAS. Williams & Stephens (2004) developed a multi

level, multi target treatment approach, starting with isolated speech sounds (like consonants and vowels) and followed by CV, CVCV, CVC words, multisyllabic words, consonant cluster words, phrases and sentences and finally connected speech. It includes activities, tasks and games involving phonological awareness skills. It also works on phrase, sentence levels and prosody. The present manual is similar to that developed by them in many ways such as multi level treatment approach, simple to complex phonotactic hierarchy, pictures associated with sounds and words etc. Activities described in the present manual are based on the activities given by Williams & Stephens (2004) in their evidence based approach. They use line drawings for associating with targeted sounds or words, however in the present manual real pictures and animated pictures are used, which helps to gain the attention and interest of the individual towards the stimuli.

The treatment kit developed by Kaufman (2001) for childhood apraxia of speech aims to teach the target words using developmentally sequenced phonological processes (like segregation of vowels in diphthongs, epenthesis), simplifying speech motor planning (Kaufman, 2001). It does not aim to match the adult form, but instead tries to match the target form. In contrast, the present manual tries to broaden the phonotactic skills of children with CAS so as to match the adult form. It is similar to the present manual as it incorporates phonotactic structures and has a set of target words with various phonotactic structures. Kaufman uses shaping technique for the elicitation of target word which is not the case in the present manual. Though the present manual has a set of target words, it associates each phoneme or syllable with a particular picture and works on improving sequencing abilities and accurate word production.

Ballard et al., (2010) focuses on use of nonsense words in treatment which will be generalised to production of meaningful words without directly working on meaningful production. One of the subsection within the manual, that is, anticipating articulatory change in repeated phonetic sequences, can be more or less thought of as sequencing syllables in production of both meaningful and non meaningful words. Ballard's treatment protocol cannot be used for completely nonverbal children who do not produce atleast 4 syllable initial consonants and 4 vowels. However, there are no such criteria for use of this manual. The present manual can be used with completely nonverbal children as it contains meaningful words associating with pictures.

Rupela & Manjula (2008)'s manual titled "Manual for treatment of developmental apraxia of speech", focuses on improving sound and word production in children with CAS by working on oromotor movements. She has included exercises (1) to overcome oral weakness, (2) for production of vowels, (3) for production of consonants, (4) for overcoming errors in word production. Individual sounds are taught using phonetic placement techniques along with visual and tactile cues. It provides word list for practice. It recommends use of articulatory drill for improving verbal skills. Though it follows simple to complex hierarchy, it does not consider the phonotactic structures and does not focus on sequencing of phonemes which is impaired in children with CAS. It majorly taps on the phonetic skills of an individual. However, the present manual focuses not only on the accurate production of phonemes, but also on sequencing phonemes and use of these phonemes in various phonotactic structures in a hierarchical manner. The present manual also helps in reducing few age inappropriate phonological processes such as reducing initial consonant deletion, reduplication etc.

The revised manual, with all the modifications incorporated and accepted by validators is presented in Appendix I. The manual has good content validity. It can be used with children with CAS which helps in improving phonetic repertoire, sequencing of sounds and word production along with broadening phonotactic skills. Field testing of the manual was not carried out due to pandemic COVID-19, which can be taken up in future.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Childhood apraxia of speech is an impairment in planning a message and programming the articulators to execute the planned message. The causative factor is linked to genetic factor such as FOXP2 mutation and is found to be an associated with other disorders such as Down syndrome, autism etc. In majority of the cases CAS is an ideopathic condition with unknown origin. Children with CAS have difficulty in sequencing phonemes, i.e., they have difficulty in transition of articulators from one particular configuration to the other. They make errors in production of sounds and words inconsistently, simplify polysyllabic and complex utterance and have dysprosodic speech. Assessment batteries tend to check for these characteristics by administering oromotor tasks, segmental analysis and suprasegmental feature analysis. Lack of gold standard factors for differentially diagnosing CAS from other speech sound disorders and the dynamic nature of the disorder makes the condition difficult to diagnose.

There are different approaches for the management of CAS. Motor based approaches are based on motor learning principles, linguistic approaches focuses on the phonology, semantics and syntax of the language and multi-modal communication approaches focuses on supporting verbal communication with aided AAC. Available treatment approaches focus on improving motor speech programming and execution incorporating motor learning principles.

An in depth review of literature suggests that there are limited treatment approaches which are evidence based. Children with CAS make the best out of treatment when both phonetics and phonotactic skills are targeted during the therapy. Since phonotactic skills are language dependent, it is necessary for the clinician to

have knowledge of the language in which treatment is provided. Existing literatures reveal that the treatment packages which incorporate phonotactic skills, are available only in English. Hence, there is a need to develop treatment manuals targeting phonotactic structures in various languages. Therefore, the present study was conducted with the aim of developing a resource manual for training the phonotactic structure in Kannada for children with CAS. The objectives of this study was to develop the treatment manual and to content validate it.

The present study was carried out in three phases. The first phase was to review the existing literature specific to CAS and its treatment. The information on CAS was collected through databases, journals and books. It was then compiled and organised for better understanding. Based on the review, the current status of diagnosis and treatment for CAS was understood. Lack of treatment manuals incorporating phonetic and phonotactic skills were brought to view during this process leading the need for the present study.

The second phase was to develop the manual for training phonotactic structures in Kannada for children with CAS in the age range of 2-6 years. Initially, the phonotactic structures of Kannada were studied. The present manual is developed based on the phonetic and phonological processing impairment underlying CAS. Different levels in the manual helps in improving or broadening the phonetic repertoire of the individual. The subsections of each level aims to improve phoneme sequencing and phonotactic skills of children with CAS. The levels are arranged in the order of developmental speech sound acquisition. Within each level, the subsections are arranged from simple to complex phonotactic hierarchy. Classifying the manual into different levels helps clinicians to choose appropriate level for the

treatment of the child. A daily record form and a monthly record form are provided at the end of the manual for tracking the progress of the child.

The final phase was to content validate the manual. It was carried out by obtaining feedback from three expert Speech-Language Pathologists in the field of assessment and treatment of CAS /phonological disorders. They were asked to judge each stimuli based on parameters such as familiarity, appropriateness, stimulability, trainability, likeability and colour & appearance. Based on the feedback received, the manual was modified accordingly. Based on the content validation, the final version of the manual was developed.

The manual will guide students trained in the field of speech-language pathology, SLPs and caregivers of children with CAS in broadening the phonetic and phonotactic repertoire of children with CAS. The manual can also be used for children with suspected CAS and severe phonological disorders as well, as it will be based on phonotactic patterns consisting of both simple and complex structures and children with suspected CAS and phonological disorders also exhibit problems in the phonotactic structure. Further, the manual can be used for adults with severe to profound apraxia of speech to help sequence phonemes. It provides playful activities for eliciting targeted speech sounds in varied phonotactic structures of Kannada language. Further, multiple analogies for word production are given so that analogy appropriate for the child can be used. It will help the clinician in choosing an appropriate level and appropriate syllable structure to begin treatment easily, as the levels are differentiated based on acquisition of speech sounds and the subsections are organised from simple to complex phonotactic hierarchy.

Thus, the outcome of the study was a treatment manual, validated for its contents by experts in the area of speech-language pathology. The manual has been designed based on the speech characteristics observed to be present in children with CAS and based on the clinical evidences reviewed in literature. The manual targets most of the sounds in Kannada, in CV, CVCV, CV1CV2, C1V1C2V2, VCCV and CVCCV structures. It is presumed that the manual will help in improving the phonetic and phonotactic skills of individual with CAS. However, the manual has not been validated on the clinical population. It targets only bisyllabic structures. Other polysyllabic structure and complex word structures such as clusters are not targeted in this manual. The manual can be validated by using it for treatment of children with CAS and modifying it accordingly. The manual can be further expanded by including other polysyllabic and complex phonotactic structures of Kannada like CVCVCV, CVCCVCV, CVCVCCV etc. so that it can be used by older children and adults as well. A computerised format of the manual can be developed, which helps in easy access to, pictures associated with phonemes and build words or activities in short duration.

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Appendix I

RESOURCE MANUAL IN KANNADA FOR TRAINING PHONOTACTIC STRUCTURE IN CHILDHOOD APRAXIA OF SPEECH

GENERAL INSTRUCTIONS

The manual comprises of target stimuli for training phonetic and phonotactic skills and has been developed for 2 - 6 years old children with childhood apraxia of speech. It helps children to acquire and use various phonemes in different phonotactic structures. The target stimuli are presented in a developmental hierarchy. Each target stimuli is associated with a particular picture, which acts as a cue for production of a particular phoneme/word. The stimuli are grouped under seven levels based on the phonemes targeted. Stimuli with CV, harmonised CVCV, CV1CV2, C1VC2V, C1V1C2V2, VCCV, and CVCCV structures along with associated pictures are incorporated in each level along with a few play based activities.

Here are a few tips to follow:

1. Initially, choose a target phoneme which is present in the child's expressive vocabulary but has trouble sequencing it.
2. Use multiple modalities for modelling the correct production. Provide the child with auditory, visual, tactile and kinaesthetic cues as and when required.
3. Use backward chaining, forward chaining or successive approximation. Do NOT segment the words into individual sounds.
4. Model the utterance using natural melody or in a sing song pattern. Do NOT speak in a robotic or monotonous way.
5. Appreciate every attempt of the child along with appropriate cueing strategies, but do NOT correct every speech error.
6. Practice intensive treatment. Elicit each target stimuli multiple number of times.
7. Continuous practice for longer duration is not recommended as the same can induce fatigue.

8. Provide knowledge of performance when the child is acquiring a new motor skill and provide knowledge of results once the child is able to execute a particular motor skill partially.
9. Reinforcement strategies should be incorporated during treatment.
10. Encourage the child to self monitor their own speech.
11. Counsel the parents to use trained words in more natural contexts.
12. Auditory discrimination should be worked upon only if the child has issues with it.

Guidelines for using the manual:

The manual is divided into seven levels. Each level targets a particular set of phonemes. Each level has subsections targeting a phoneme in different contexts (like in context of long vowel and short vowel), and in different word structures which are as follows.

a. **Fun with CV forms with consistency of consonant and lax vowel**.

   This subsection aims to improve production of a particular phoneme with different vowel context and aids in multiple repetition of each syllable.

   Instructions: Present the picture along with othographic form to the child and ask the child to listen and watch you carefully as you produce the syllable. Model the production of syllable. Ask the child to point to the picture and say the corresponding sound.

b. Fun with CV forms with the consistency of long vowels.

   This subsection aims to improve production of a particular phoneme with a long vowel context. A picture of a scale or stick in association with targeted picture stimuli acts as cue for production of CV with long vowel context.

Instructions: Present the target stimuli along with the picture of stick or scale ask the child to listen and watch you carefully as you produce the syllable. Place your hand on the scale/stick picture and slide it through its length along with lengthening the vowel in CV form. Ask the child to do the same.

c. **Fun with CV forms with consistency of aspirated consonant and vowel.**

This subsection aims to improve production of aspirated sounds. A picture of a cloud, blowing air, in association with the target stimuli, acts as a cue for production of aspirated consonant in CV.

Instructions: Present the target stimuli along with the picture of 'cloud blowing air'. Ask the child to listen and watch you carefully as you produce the aspirated phneme. Place the child's hand infront of your mouth, point to the 'cloud blowing air' picture, and produce the aspirated consonant. Encourage the child to follow you.

d. **Anticipating articulatory change in repeated phonetic sequences**

This subsection aims to improve production of sequence of sounds. **Instructions:** Present the series of target stimuli as given in the manual. Point to the pictures and produce the corresponding syllable. Ask the child to so the same.

e. **Words**

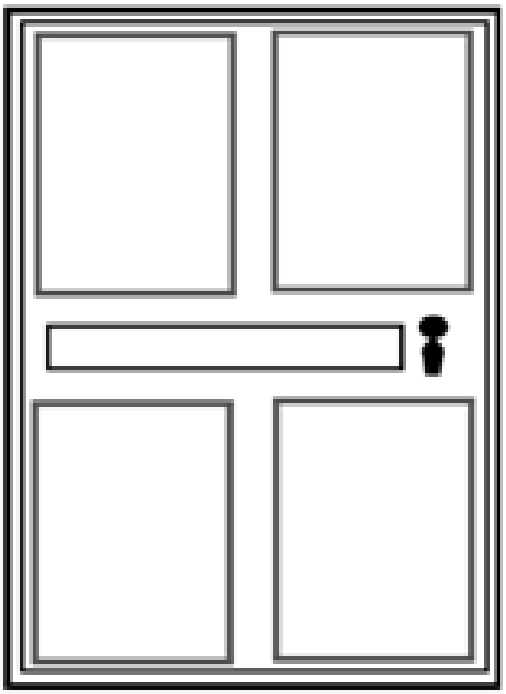
This subsection aims to improve production of words of different structures. Different analogies to aid in the production of words are given below with example. Choose the one which is most appropriate for your child and use it to teach production of words.

Note: For teaching geminates in word context, highlight the picture associated with a particular sound which has to be produced as a geminate. Place a piece of

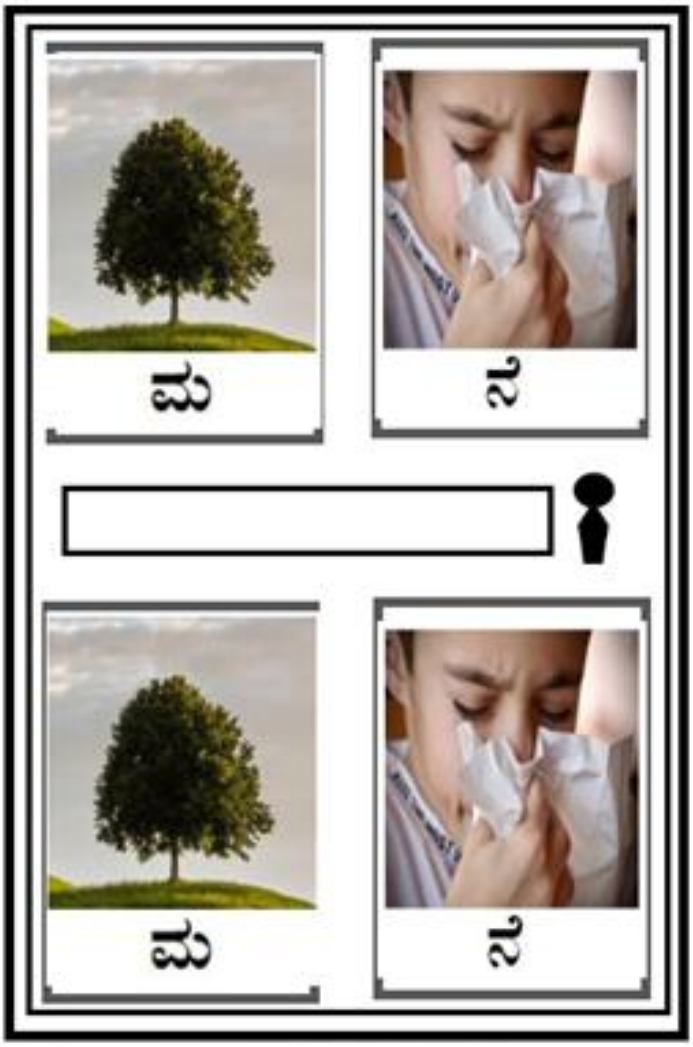
clay dough below the picture of the geminate and press the clay along with the production of geminate verbally. Encourage the child to produce the geminate as you did.

1) Door analogy

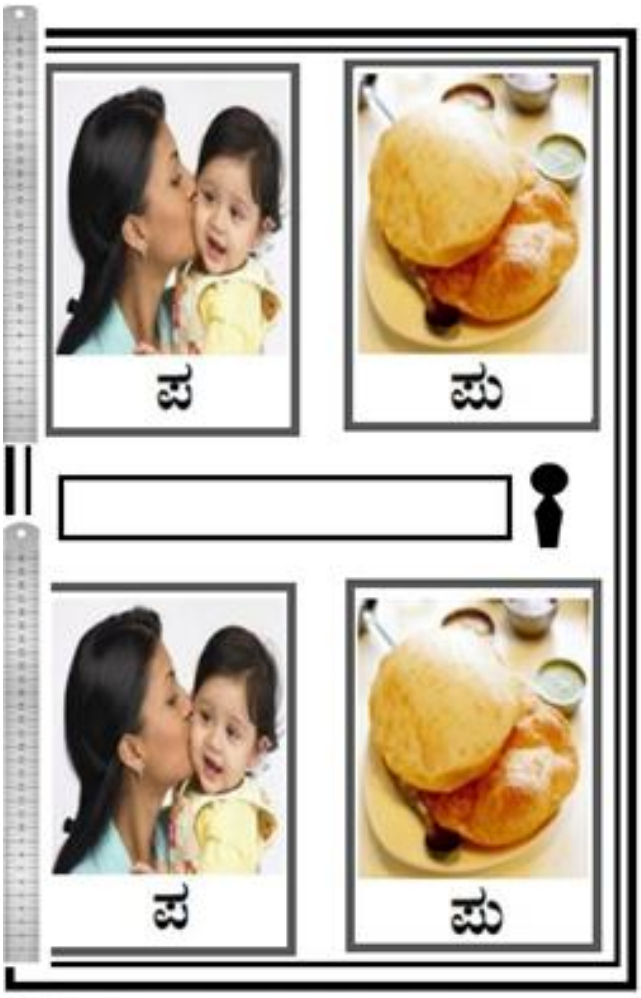
Clinician should point to each picture on the closed door in a sequence so as to elicit the target word and the child has to say the corresponding associated sound. Clinician then points to the target picture present inside the open door and the child has to name it.



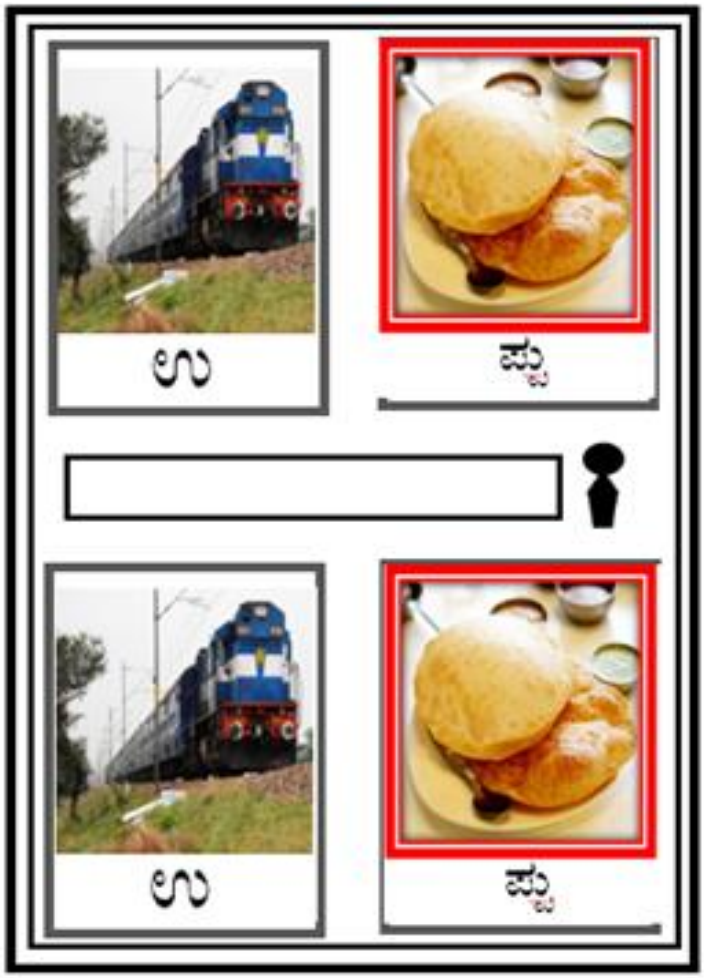
Example 1: For word production



Example 2: For words with long vowels. (Model the production of long vowel by pointing to the scale and sliding the finger through its length, to indicate long vowel).



Example 3: For geminate production. (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).



2) Addition analogy

Point to the first picture, and encourage the child to say the sound associated with it. Then point to the next picture and again child should be encouraged to say the sound associated with it. Finally, point to the target word and name it and the child is expected to name the final picture.

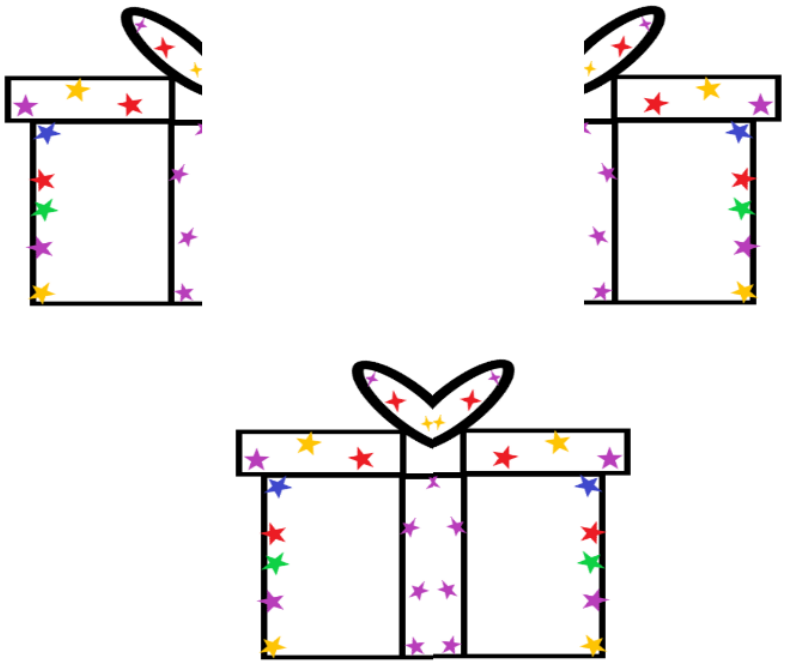
Example 1: For word production

Example 2: For words with long vowels (Model the production of long vowel by pointing to the scale and sliding the finger through its length, to indicate long vowel).

Example 3: For geminate production (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).

3) Gift box analogy

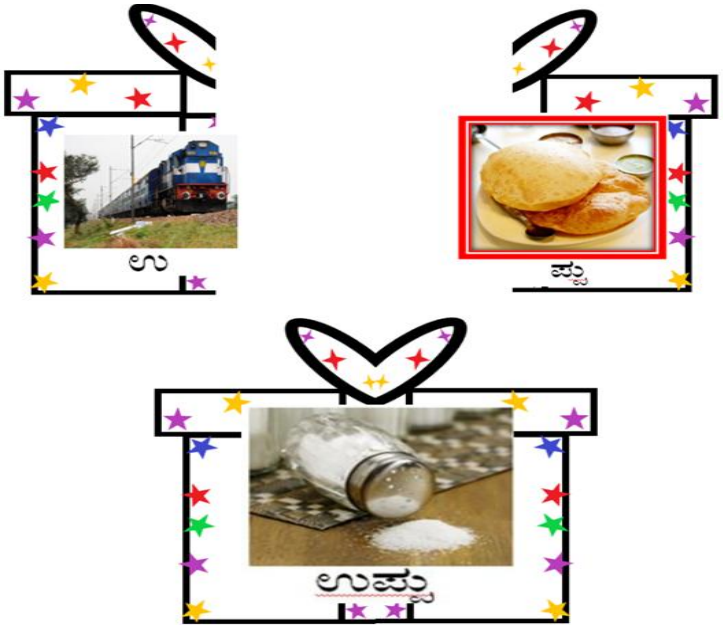
Point to the first picture, and encourage the child to say the associated sound. Then point to the next picture and again encourage the child to say the associated sound. Finally point to the target picture (in the gift box) and name it and encourage the child say the target word.



Example 1: For word production

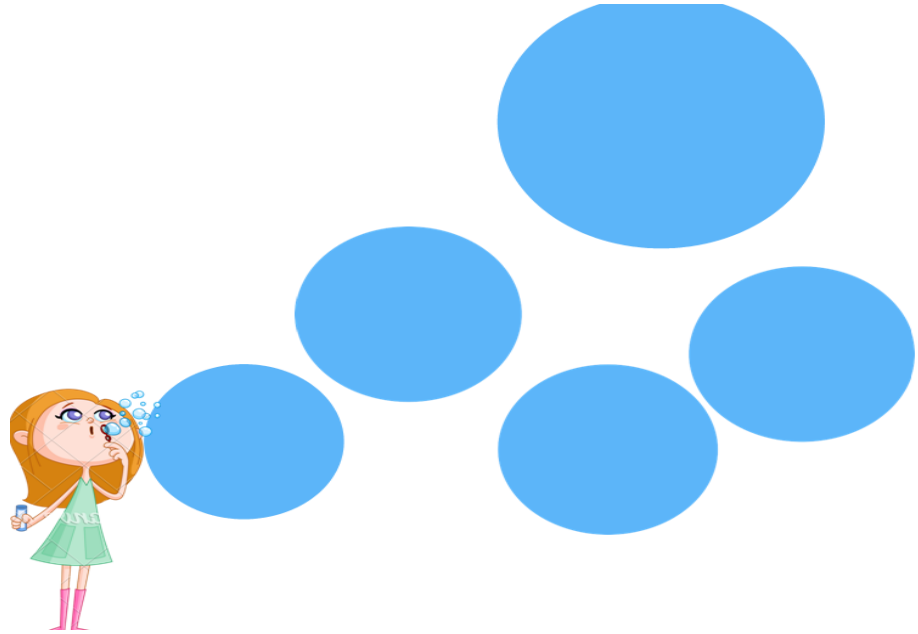
Example 2: For words with long vowels. (Model the production of long vowel by pointing to the scale and sliding the finger through its length, to indicate long vowel).

Example 3: For geminate production. (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).

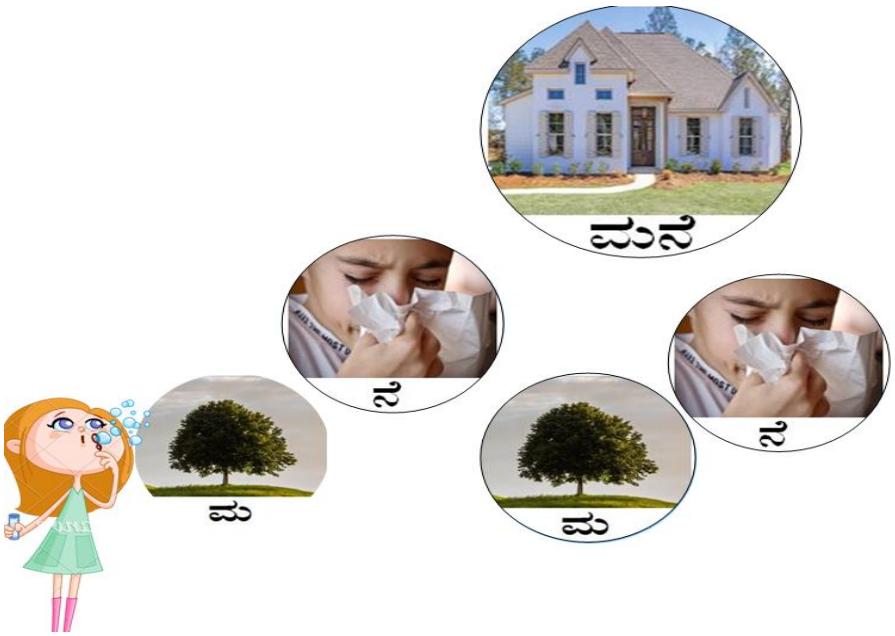


4) Bubble analogy

Point to each picture in a particular sequence so that it forms a word, and encourage the child to say the associated sounds. Finally point to the target picture (at the big bubble) and encourage the child to name the target word.

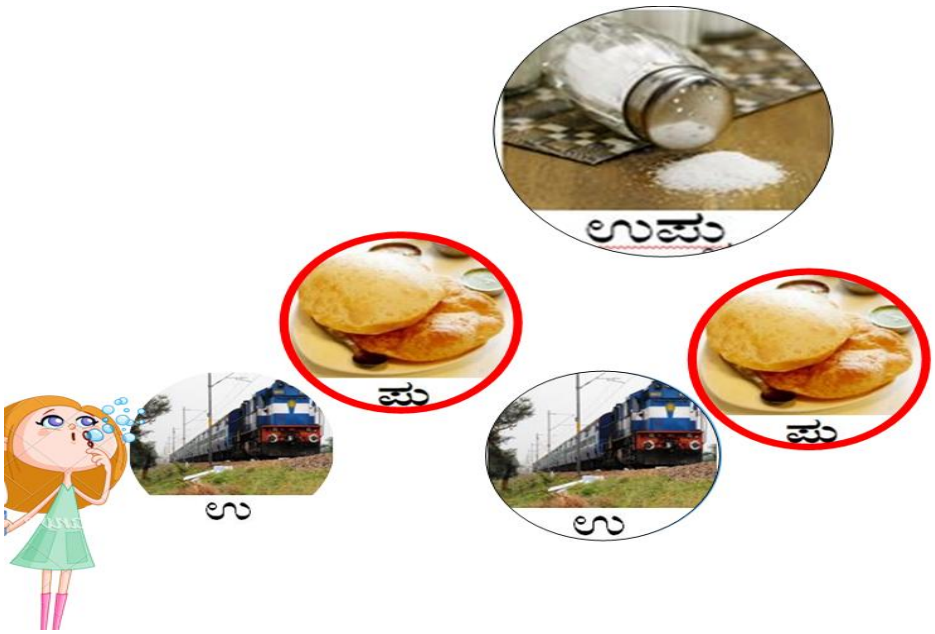


Example 1: For word production



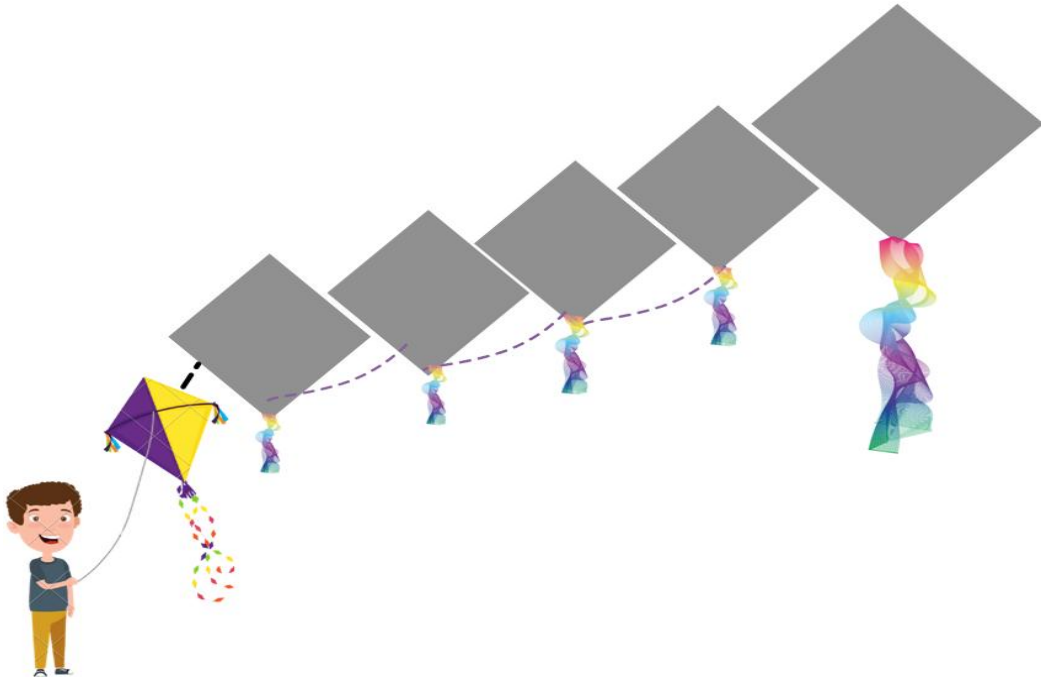
Example 2: For words with long vowels. (Model the production of long vowel by pointing to the stick and sliding the finger through its length, to indicate long vowel).

Example 3: For geminate production. (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).



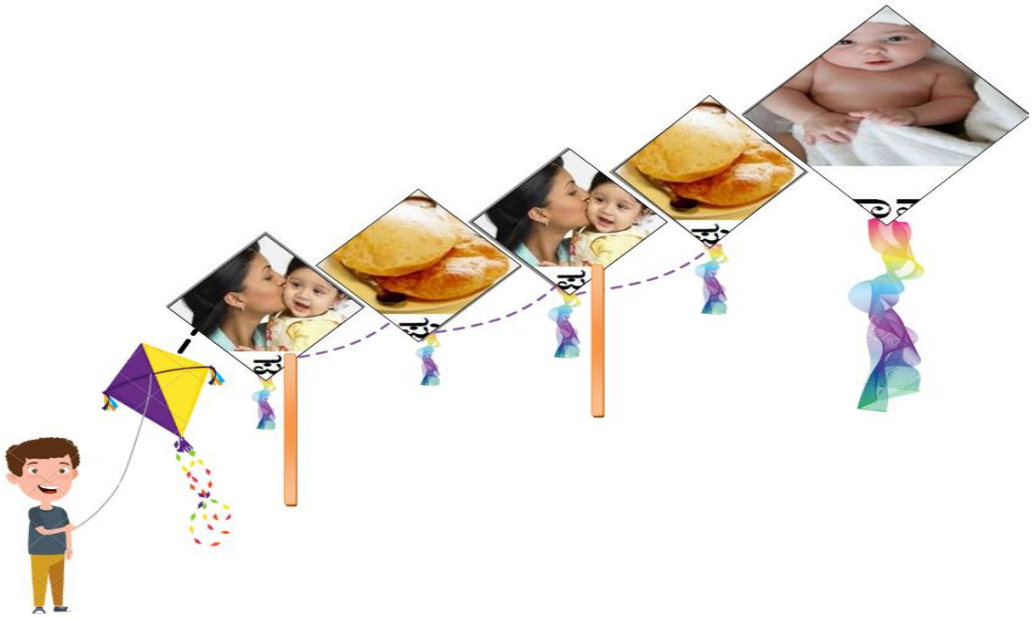
5) Kite analogy

Point to each picture and produce the associated sound. Now, encourage the child to say the sounds by pointing to each picture. Finally point to the target picture (at the biggest kite) and encourage the child to name the target word.



Example 1: For word production

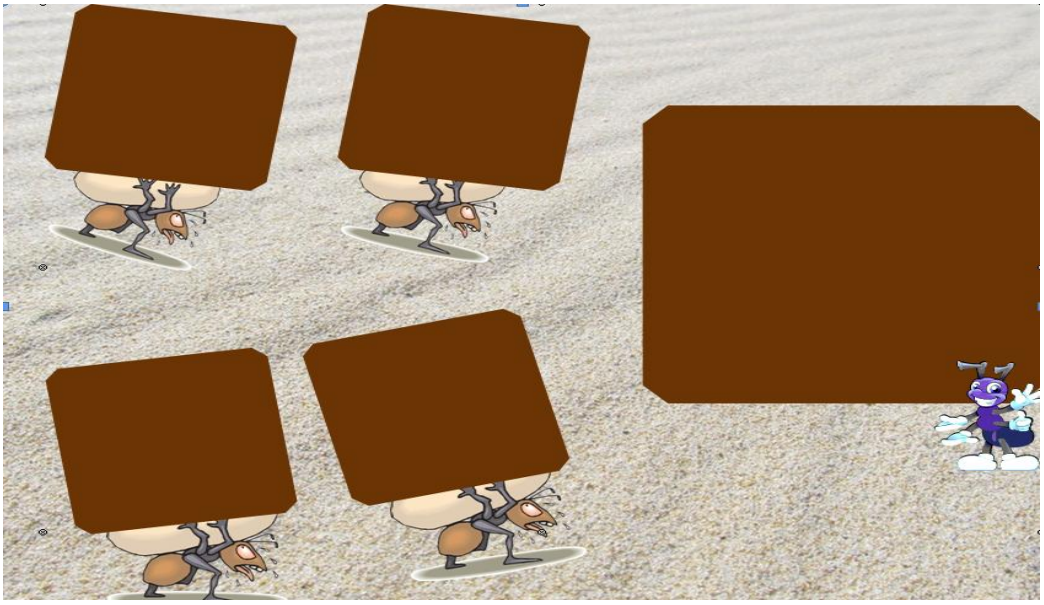
Example 2: For words with long vowels. (Model the production of long vowel by pointing to the stick and sliding the finger through its length, to indicate long vowel).



Example 3: For geminate production. (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).

6) Ant analogy

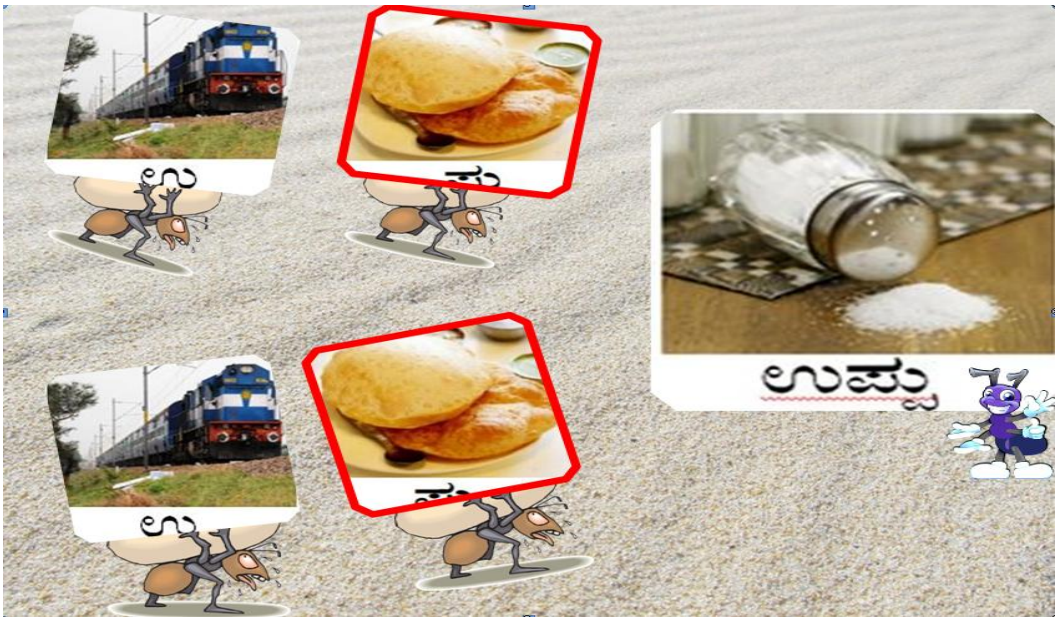
Point to each picture (in a particular sequence such that it forms a word) and say the associated sound. Now, encourage the child to say the sounds by pointing to each picture. Finally point to the target picture and encourage the child to name the target word.



Example 1: For word production

Example 2: For words with long vowels. (Model the production of long vowel by pointing to the stick and sliding the finger through its length, to indicate long vowel).

Example 3: For geminate production. (Highlight the picture associated with a particular phoneme which has to be produced as a geminate and model its production).



f. Play based activities.

This subsection aims in spontaneous production of target words and multiple repetitions of the target words. The play based activities given in each level are different and the instructions for carrying out the activities are given along with each of the activity.

Level 1

1.1 Fun with CV forms with consistency of consonant and short vowel





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ಪಿ ಪಿ ಪಿ ಪಿ ಪಿ





ಪೆ ಪೆ ಪೆ ಪೆ ಪೆ





ಪೊ ಪೊ ಪೊ ಪೊ ಪೊ

ಬ ಬ ಬ ಬ ಬ

ಬಿ ಬಿ ಬಿ ಬಿ ಬಿ [2]

ಬು ಬು ಬು ಬು ಬು

ಬೆ ಬೆ ಬೆ ಬೆ ಬೆ

ಬೊ ಬೊ ಬೊ ಬೊ ಬೊ





ಮ ಮ ಮ ಮ ಮ





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1.2Fun with CV forms with consistency of consonant and long vowel

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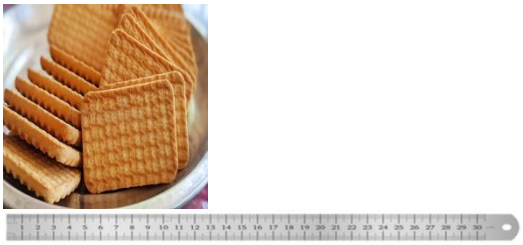

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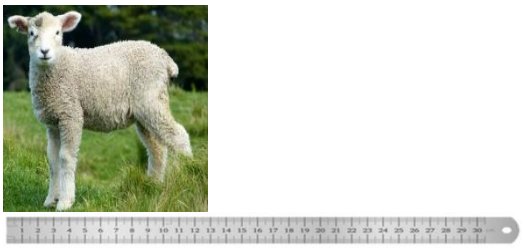

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Note: Other CV syllables with long vowels can be taught in similar way.

1.3 Fun with CV forms with consistency of aspirated consonant and vowel

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Note: Other aspirated sounds can be taught in similar way.

1.4 Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only


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Note: Following probes can also be used for therapy.

ಬಿಬಿಬಿಬಿಬೆ	ಪುಪುಪುಪೊ	ಮಮಮಮಮೆ
ಭೊಭೊಭೊಭೊಭು	ಫಫಫಫಫು	ಮುಮುಮುಮುಮೊ
ಬೇಬೇಬೇಬೇಬೋ	ಪೇಪೇಪೇಪೇಪೂ	ಮೇಮೇಮೇಮೇಮೋ

b) Alternate


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Note: Following probes can also be used for therapy.

ಪಿಪೆಪಿಪೆ	ಬಬಿಬಬಿ	ಮಿಮೆಮಿಮೆ
ಪಾಪೂಪಾಪೂ	ಬೀಬೇಬೀಬೇ	ಮೂಮೋಮೂಮೋ
ಫುಫಿಫುಫಿ	ಭೆಭಭೆಭ	ಮೊಮಮೊಮ

c) Randomly alternating sequence


ಪು


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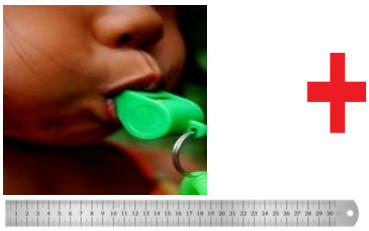
Note: Following probes can also be used for therapy.

ಪಿಪೆಪಿಪಿಪೆ	ಬಬಿಬಬಬಿ	ಮಿಮಿಮೆಮಿಮೆ
ಪಾಪಾಪೂಪಾಪೂ	ಬೀಬೇಬೇಬೀಬೇ	ಮುಮೊಮುಮೊಮೊ
ಫುಫುಫಿಫುಫಿ	ಭೆಭೆಭಭೆಭ	ಮೊಮುಮೊಮೊಮು

1.4 Words

1.51 CVCV


ಪೀ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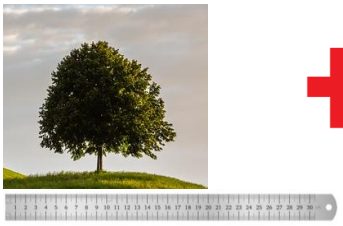
ಪೀಪಿ

ಬಾ +  ಬ = 

ಬಾಬ



ಮಾ +  ಮ = 

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Note: Following probes can also be used for therapy.

ಪಾಪ	ಮೀಮೀ(Fish)	ಮೇಮೇ(Goat)

1.52 CV1CV2

ಪಾ +  ಪು = 

ಪಾಪು


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Note: Following probes can also be used for therapy.

ಬೇಬಿ	ಬಾಬು	ಪಾಪಿ

1.53 VCCV


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Note: Following probes can also be used for therapy.

ಅಮ್ಮ	ಅಪ್ಪಿ	ಅಬ್ಬು
ಉಬ್ಬು	ಒಬ್ಬ	ಒಪ್ಪು
ಇಪ್ಪೀ	ಎಮ್ಮೆ	

1.54 VCCV


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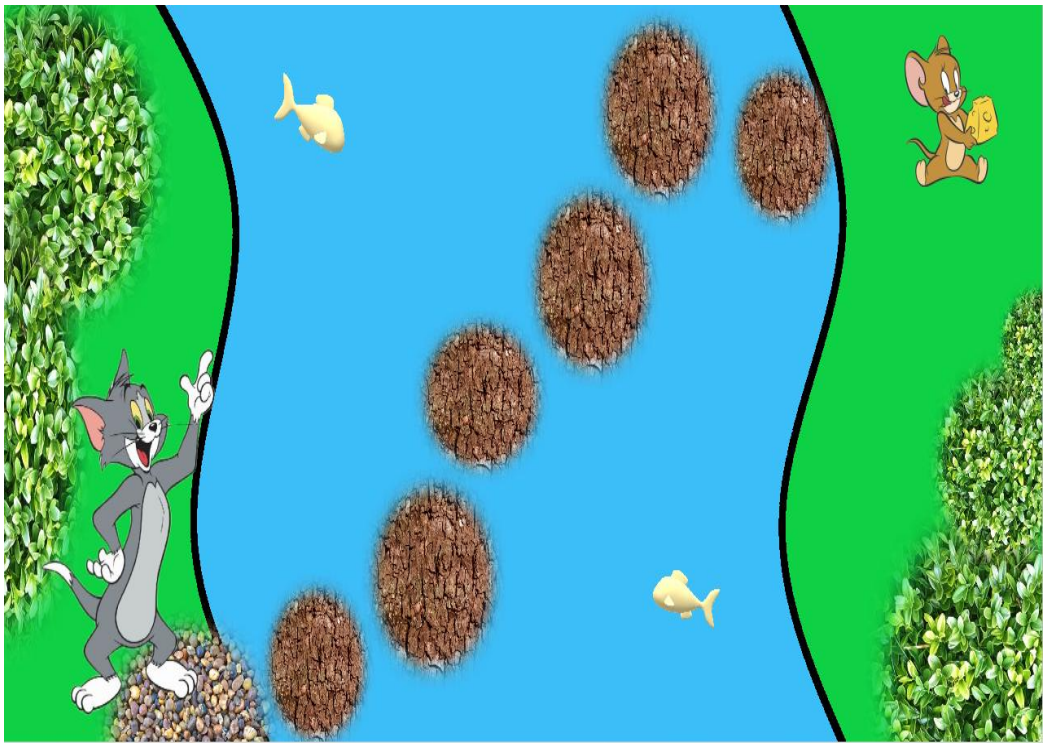
Note: Following probes can also be used for therapy.

ಪಪ್ಪಿ	ಮಮ್ಮಿ	ಮುಪ್ಪು
ಪಮ್ಮಿ	ಬೊಬ್ಬೆ	

1.5 Play based activity

Activity 1: “Crossing the river” game makes the therapy a fun activity and helps in repetitive practice.

Instructions: Introduce the following picture along with cut outs or models (if available) of Tom and Jerry. Encourage the child to say /ba/. Every time child says /ba/, move Tom, the cat, from one stone to the other, crossing the river, to catch Jerry, the mouse.

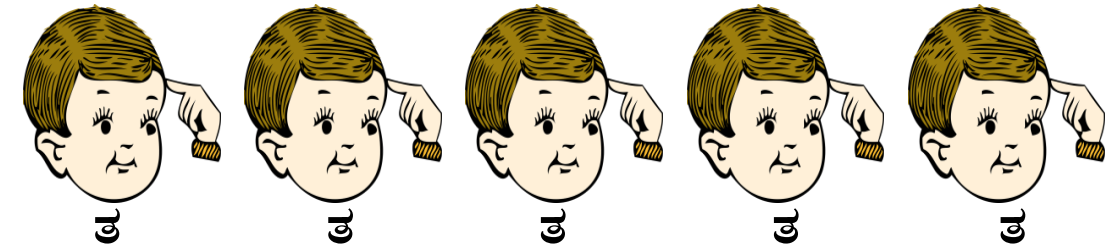


Activity 2: To make the therapy sessions interesting for the child, puzzles can be used.

Instructions: Place the cutout of a scoop of ice cream on the cone, whenever the child says /mammu/. So after 5-6 repetitions, complete picture of ice cream will be connected and child can be reinforced with real ice cream or any other reinforcer.

Level 2

2.1Fun with CV forms with consistency of consonant and lax vowel

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100 100 100 100 100

ನು ನು ನು ನು ನು

ನೆ ನೆ ನೆ ನೆ ನೆ

ನೊ ನೊ ನೊ ನೊ ನೊ

2.2Fun with CV forms with consistency of consonant and tense vowel

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Note: Other CV syllables with tense vowels can be taught in similar way.

2.3Fun with CV forms with consistency of aspirated consonant and vowel

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ಧ

Note: Other aspirated sounds can be taught in similar way.

2.4Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only





ತಿ ತಿ ತಿ ತಿ ತೆ





ದ ದ ದ ದ ದಿ





ನೊ ನೊ ನೊ ನೊ ನೆ

Note: Following probes can also be used for therapy.

ತ ತ ತ ತ ತು	ದು ದು ದು ದು ದ	ನಿ ನಿ ನಿ ನಿ ನೆ
ತೂ ತೂ ತೂ ತೂ ತೋ	ದೀ ದೀ ದೀ ದೀ ದೇ	ನೇ ನೇ ನೇ ನೇ ನೂ
ಥ ಥ ಥ ಥ ಥಿ	ಥೊ ಥೊ ಥೊ ಥೊ ಥೆ	ನು ನು ನು ನು ನ

b) Alternate




ತ ತು ತ ತು


ದೆ


ದೊ


ದೆ


ದೊ


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ನು


ನ


ನು

Note: Following probes can also be used for therapy.

ತು ತೊ ತು ತೊ	ದ ದಿ ದ ದಿ	ನಿ ನೆ ನಿ ನೆ
ತೇ ತೀ ತೇ ತೀ	ದೋ ದೂ ದೋ ದೂ	ನೂ ನೋ ನೂ ನೋ
ಥಿ ಫ ಥಿ ಫ	ಧೆ ಧಿ ಧೆ ಧಿ	ನೆ ನ ನೆ ನ

c) Randomly alternating sequence


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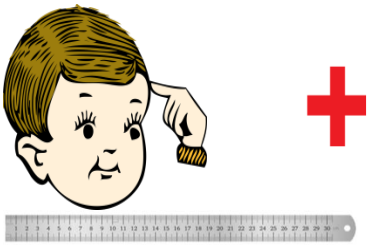
ನೊ ನಿ ನಿ ನೊ ನಿ

Note: Following probes can also be used for therapy.

ತಿ ತೆ ತೆ ತಿ ತಿ	ದ ದಿ ದಿ ದ ದ	ನ ನಿ ನ ನ ನಿ
ತಾ ತೀ ತಾ ತಾ ತೀ	ದಾ ದೇ ದೇ ದಾ ದೇ	ನೇ ನೇ ನಾ ನೇ ನಾ ನಾ
ಥು ಥೊ ಥು ಥು ಥೊ	ಧು ಧು ಧೊ ಧು ಧೊ	ನೊ ನೊ ನೆ ನೊ

2.5 Words

2.51 CVCV



ತಾ ತ ತಾತ



ತೂ ತು ತೂತು

2.52 C1V1C2V2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ಬಾ


ತು


ಬಾತು


ದೀ


ಪ


ದೀಪ

Note: Following probes can also be used for therapy.

ಮೀನು	ನದಿ	ತೆನೆ
ಧೂಪ		

2.53 VCCV


ಅ


ನ್ನ


ಅನ್ನ


ಎ


ತ್ತು


ಎತ್ತು


ಒ


ದ್ದೆ

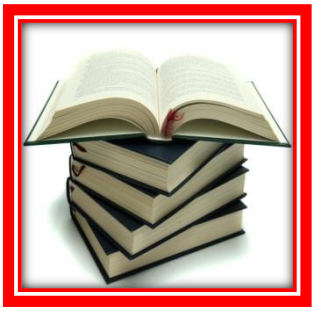

ಒದ್ದೆ

Note: Following probes can also be used for therapy.

ಅತ್ತೆ	ಒತ್ತು	ಉದ್ದ

2.54 CVCCV


ತ


ಬ್ಬು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ನ್ನು


ಬನ್ನು


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ಪ್ಪ


ದಪ್ಪ

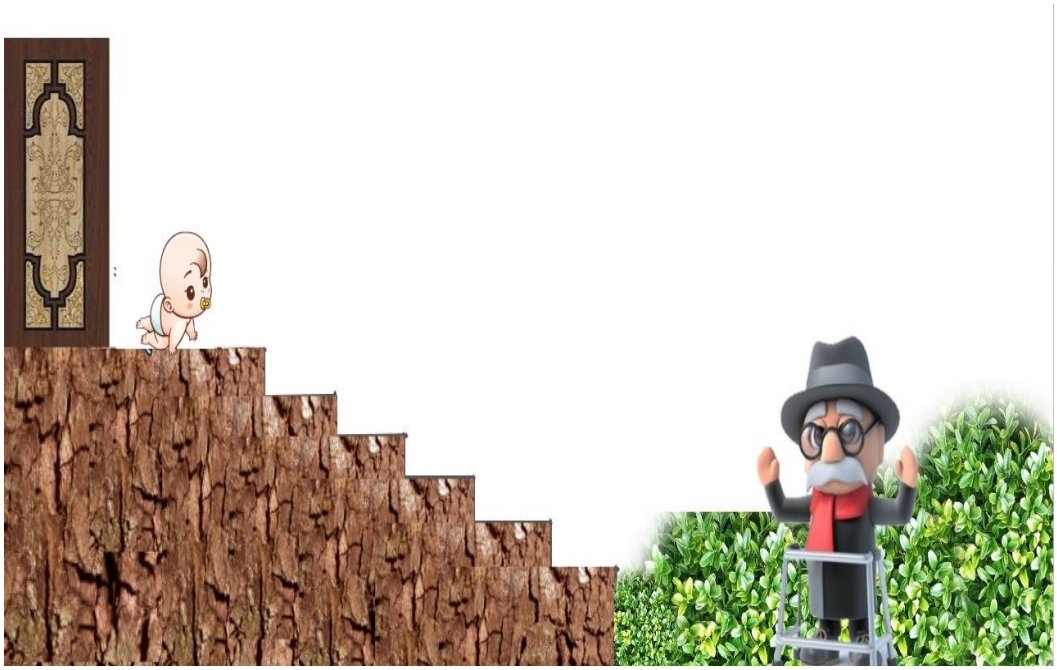
Note: Following probes can also be used for therapy.

ತುಪ್ಪ	ದತ್ತ	ಬೆನ್ನು
ತಮ್ಮ	ಹದ್ದು	ಪೆನ್ನು
ತಪ್ಪು	ಮುದ್ದೆ	ಮುನ್ನ

2.6 Play based activity

Activity 1: “I got you” game makes the therapy a fun activity and helps in repetitive practice.

Instructions: Every time the child says /t̲a:t̲a/, move the cutout of grandfather picture, closer to the baby.



<u>Activity 2:</u> "Fishing" game can be used to make the therapy session a playful one.

Instructions: Every time the child says /mi:nu/, give the stick to the child so that he/she gets to catch a fish.

Level 3

3.1Fun with CV forms with consistency of consonant and lax vowel





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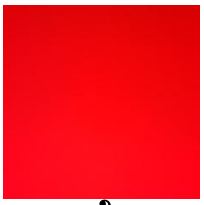
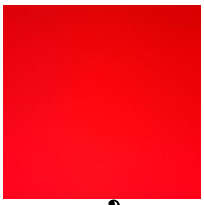


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ಗ ಗ ಗ ಗ ಗ





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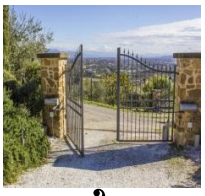
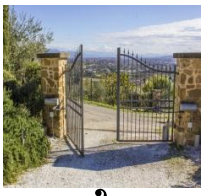

ಗೆ ಗೆ ಗೆ ಗೆ ಗೆ





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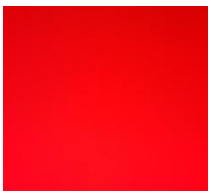
3.2 Fun with CV forms with consistency of consonant and long vowel



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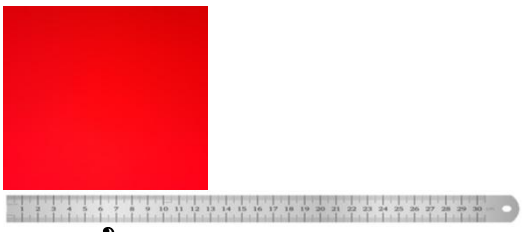

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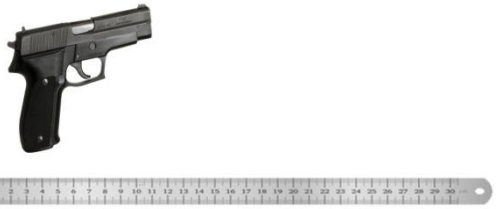

ಗಾ

Note: Other CV syllables with tense vowels can be taught in similar way.

3.3 Fun with CV forms with consistency of aspirated consonant and vowel.

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Note: Other aspirated sounds can be taught in similar way.

3.4 Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only


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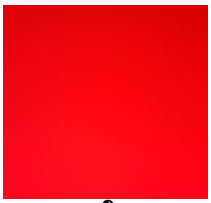
ಗೆ

Note: Following probes can also be used for therapy.

ಕೆಕೆಕೆಕೊ	ಕೀಕೀಕೀಕೀಕೇ	ಖುಖುಖುಖುಖೆ
ಗೊಗೊಗೊಗೊಗ	ಗೀಗೀಗೀಗೀಗೋ	ಘಘಘಘಘಿ

b) Alternate


ಕೆ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Note: Following probes can also be used for therapy.

ಕುಕೆಕುಕೆ	ಕೋಕೀಕೋಕೀ	ಖಖಿಖಖಿ
ಗಿಗುಗಿಗು	ಗೋಗೂಗೋಗೂ	ಫಘುಫಘು

c) Randomly alternating sequence:


ಕ


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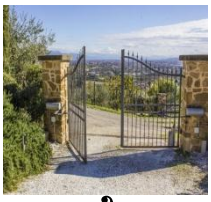

ಗೆ


ಗೊ

Note: Following probes can also be used for therapy.

ಕುಕೆಕೊಕೆ	ಕಾಕೀಕೀಕಾ	ಖೊಖಿಖಿಖೊ
ಗಿಗುಗುಗಿ	ಗೋಗೇಗೋಗೋ	ಫಘುಘುಫ

3.5 Words:

3.51 CVCV

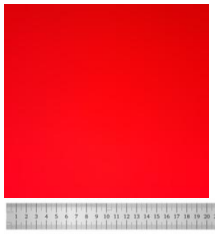


ಕೋ ಕೋ ಕೋಕೋ

3.52 CV1CV2



ಕಾ ಕು ಕಾಕು



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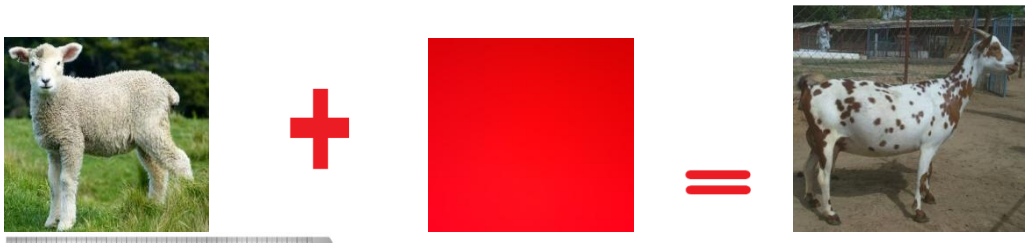
3.53 C1VC2V

ಕೂ ಗು ಕೂಗು

ಮೂ ಗು ಮೂಗು



ಮೇ ಕೆ ಮೇಕೆ

Note: Following probes can also be used for therapy.

ಬಕ	ನೂಕು	ಕೆನೆ
ಮಗ	ಪೋಗೋ	ನೆಗೆ

3.54C1V1C2V2

ಕೋ ತಿ ಕೋತಿ

ಗೂ ಬೆ ಗೂಬೆ [3]

ಮು ಖ ಮುಖ

Note: Following probes can also be used for therapy.

ಕಾಗೆ	ಕೋಪ	ತೂಕ
ಗೋಪಿ	ಗೋದಿ	ತೂಗು

3.55 VCCV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ಕ್ಕ


ಅಕ್ಕ


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3.56 CVCCV


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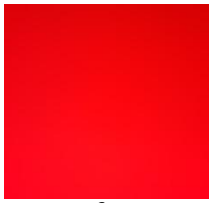
ತ್ತೆ


ಕತ್ತೆ


ಕೆ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ಪಿ

ಗ್ಗಿ

ಪಿಗ್ಗಿ

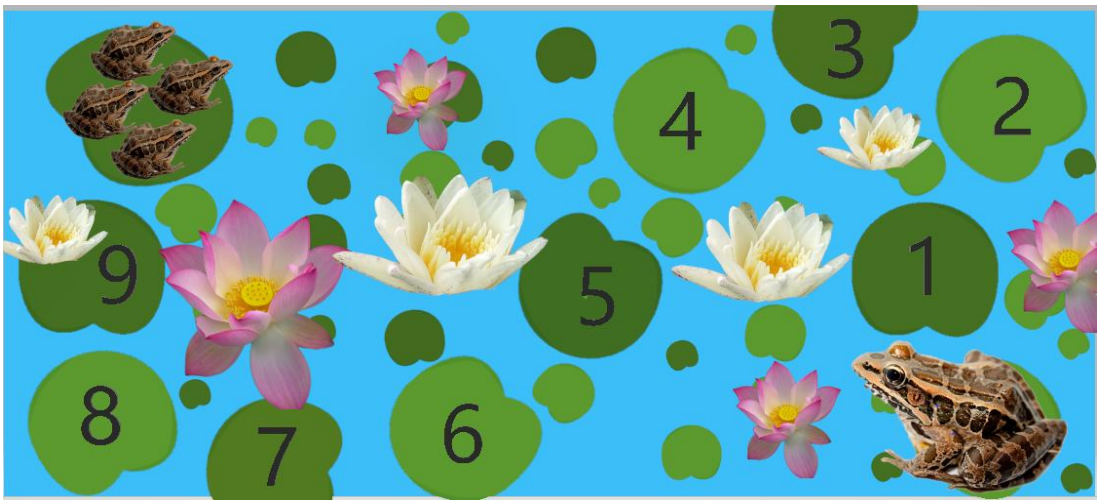
Note: Following probes can also be used for therapy.

ಕೊಕ್ಕು	ಬೆಕ್ಕು	ಮಿಕ್ಕಿ
ಕತ್ತಿ	ಕಬ್ಬು	ಕಪ್ಪು
ಕತ್ತು	ಗೊಗ್ಗ	ಗುದ್ದು

3.6 Play based activity

Activity 1: 'The baby frogs'

Instructions: Make cutouts of big and few small frogs. Encourage the child to say '/kappe ba/' or '/amma kappe ba/' and when child says it, move the cutout of big frog from one lily pad to the other. In this way elicit multiple repetitions.



Activity 2: "Find the missing part".

Instructions: preset both the pictures to the child. Encourage the child to name what is missing in the second picture by comparing it with the first picture.

Level 4

4.1 Fun with CV forms with consistency of consonant and vowel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ವಿ ವಿ ವಿ ವಿ ವಿ


ವು ವು ವು ವು ವು [1]


ಲ ಲ ಲ ಲ ಲ


ಲಿ ಲಿ ಲಿ ಲಿ ಲಿ

ಲು ಲು ಲು ಲು ಲು

ಲೆ ಲೆ ಲೆ ಲೆ ಲೆ

ಲೊ ಲೊ ಲೊ ಲೊ ಲೊ

4.2 Fun with CV forms with consistency of consonant and long vowel

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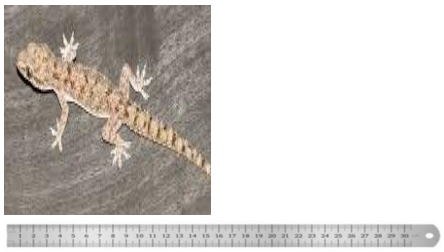

ಲೀ

Note: Other CV syllables with tense vowels can be taught in similar way.

4.3 Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only


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Note: Following probes can also be used for therapy.

ವವವವವು	ವಿವಿವಿವಿವ	ವುವುವುವುವಿ
ಲಲಲಲಲಿ	ಲುಲುಲುಲುಲೆ	ಲೊಲೊಲೊಲೊಲ

b) Alternate


ವಿ


ವು


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ವು


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ಲು


ಲ


ಲು

Note: Following probes can also be used for therapy.

ವವುವವು	ವಿವವಿವ	ವುವಿವುವಿ
ಲಲಿಲಲಿ	ಲುಲೆಲುಲೆ	ಲೊಲಲೊಲ

c) Randomly alternating sequence

ವಿ ವ ವ ವಿ

ಲಿ ಲೊ ಲೊ ಲಿ

Note: Following probes can also be used for therapy.

ವುವವವು	ವಿವವುವ	ವವಿವಿವ
ಲಲಿಲಲಿ	ಲುಲೆಲುಲೆ	ಲೊಲಲೊಲ

4.4 Words

4.41 CV1CV2

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4.42 C1VC2V


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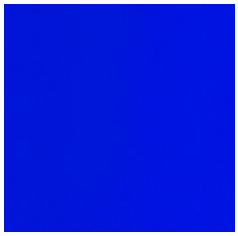
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4.43 C1V1C2V2



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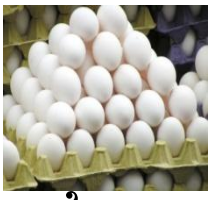
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4.44 VCCV


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Note: Following probes can also be used for therapy.

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4.45 CVCCV


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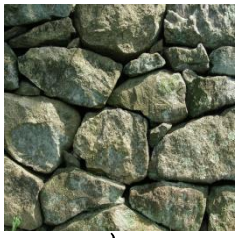
ಕಲ್ಲು

ನ

ಲ್ಲಿ

ನ್ಲಿ

Note: Following probes can also be used for therapy.

ಪಲ್ಲಿ	ಗೊಲ್ಲ	ಬೆಲ್ಲ

4.5 Play based activity

Activity 1: 'Complete thepicture'

Instructions: Present the incomplete picture along with the choices. Encourage the child to choose the missing part from among the choices by naming each of the choices.

Activity 2: "Odd one out".

Instructions: Present a group of three similar pictures and one different picture. Encourage the child to name each of them and choose the one which does not belong to that category.

a) 

b) 

Level 5

5.1Fun with CV forms with consistency of consonant and vowel


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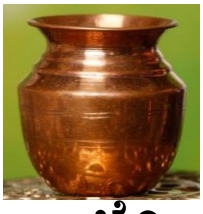
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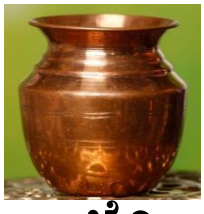
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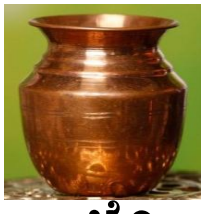
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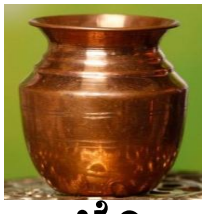
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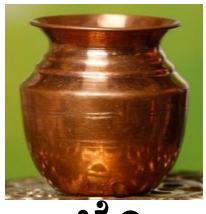
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ಜೆ ಜೆ ಜೆ ಜೆ ಜೆ





[1]

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5.2 Fun with CV forms with consistency of consonant and long vowel

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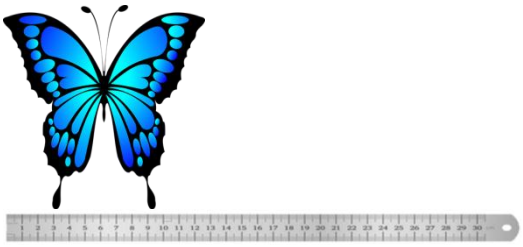

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Note: Other CV syllables with long vowels can be taught in similar way.

5.3 Fun with CV forms with consistency of aspirated consonant and vowel

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Note: Other aspirated sounds can be taught in similar way.

5.4 Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only


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Note: Following probes can also be used for therapy.

ಛಛಛಛಛು	ಚಿಚಿಚಿಚಿಚೆ	ಚೋಚೋಚೋಚೋಚೀ
ಝುಝುಝುಝುಝು	ಜೆಜೆಜೆಜೆಜ	ಜೋಜೋಜೋಜೋಜೇ

b) Alternate


ಜ


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ಚು

Note: Following probes can also be used for therapy.

ಚಚುಚಚು	ಚೀಚೇಚೀಚೇ	ಛೊಛಿಛೊಛಿ
ಜಿಜುಜಿಜು	ಜೇಜಾಜೇಜಾ	ಝೊಝುಝೊಝು

c) Randomly alternating sequence


ಚು


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ಚೊ


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ಜೊ


ಜಿ


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Note: Following probes can also be used for therapy.

ಚಚಿಚಿಚ	ಚೀಚೇಚೇಚೀ	ಛೊಛಿಛಿಛೊ
ಜಿಜಜಿ	ಜಾಜೇಜಾಜೂ	ಝೊಝುಝುಝು

5.5 Words

5.51 CVCV


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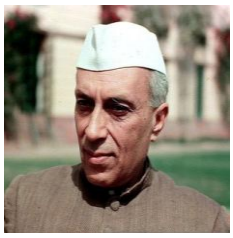
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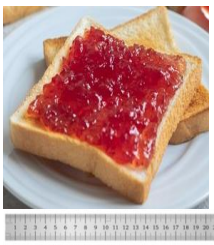
[7]
ಜೋಜೋ

5.52 CV1CV2


ಜಾ


ಜಿ


ಜಾಜಿ

5.53 C1VC2V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5.54 C1V1C2V2


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ಪೂಜೆ


ವಾ

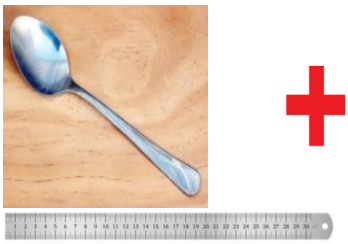

ಚು


ವಾಚು


ಬಾ


ಚು


ಬಾಚು


ಚಾ


ಕು

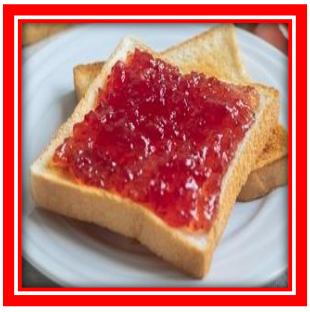

ಚಾಕು

Note: Following probes can also be used for therapy.

ಚೀಕೂ	ಮೇಜು
ಬೀಜ	ಜೇಬು

5.56 VCCV


ಅ


ಜ್ಜ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5.57 CVCCV


ಚಿ


ನ್ನು


ಚಿನ್ನು


ಚೆ


ಲ್ಲು


ಚೆಲ್ಲು


ಗೆ


ಜ್ಜಿ


ಗೆಜ್ಜಿ [1]

Note: Following probes can also be used for therapy.

ಮುಚ್ಚು	ಕೊಚ್ಚೆ	ಬಜ್ಜಿ
ಜಿಪ್ಪು	ಪಿಜ್ಜಾ	ಗೊಜ್ಜು

5.6 Play based activity

Activity 1: "Fill in the blank"

Instructions: Remove the target word from a series, as given below. Encourage the child to fill the blank using the correct option and name it.


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a) 
ವಾಚು

b) 
ಬಾಚು

c) 
ಚೂಪು

ಗೆ

ಜ್ಜೆ

=

_____

_____

a)

ಚೆಲ್ಲು

b)

ಅಜ್ಜಿ

c)

ಗೆಜ್ಜೆ

<u>Activity 2</u>: 'Get the chocolate'

Instructions: Place an empty jar and a cup of water infront of the child. Put a chocolate wrapper of child's interest inside the empty jar. Encourage the child to say /ca:kI/ or /ca:kI be:ku/ or /ca:kI t̲a:/. Whenever child says any of it, pour a cup of water into the jar, so that the chocolate wrapper comes up. After that, child can be reinforced with a real chocolate.

1

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Level 6

6.1Fun with CV forms with consistency of consonant and vowel

ಡ ಡ ಡ ಡ ಡ [2]

ಡು ಡು ಡು ಡು ಡು [8]

ಡಿ ಡಿ ಡಿ ಡಿ ಡಿ

ಡೆ ಡೆ ಡೆ ಡೆ ಡೆ [9]

ಡೊ ಡೊ ಡೊ ಡೊ ಡೊ [10]

ಟು ಟು ಟು ಟು ಟು

ಟ ಟ ಟ ಟ ಟ

ಟಿ ಟಿ ಟಿ ಟಿ ಟಿ

ಟೆ ಟೆ ಟೆ ಟೆ ಟೆ

ಟೊ ಟೊ ಟೊ ಟೊ ಟೊ

ಣು ಣು ಣು ಣು ಣು

[11]

[12]

ಣ ಣ ಣ ಣ ಣ

ಣೆ ಣೆ ಣೆ ಣೆ ಣೆ

[13]

ಣೆ ಣೆ ಣೆ ಣೆ ಣೆ

6.2Fun with CV forms with consistency of consonant and long vowel

ಟಿ

ಟೀ

ಡೊ

ಡೋ

Note: Other CV syllables with long vowels can be taught in similar way.

6.3Fun with CV forms with consistency of aspirated consonant and vowel


ಥ


ಢ

Note: Other aspirated sounds can be taught in similar way.

6.4 Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only





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ಡೊ ಡೊ ಡೊ ಡೊ ಡ


ಟೆ


ಟೆ


ಟೆ


ಟೆ


ಟಿ

Note: Following probes can also be used for therapy.

ಟಿಟಿಟಿಟಿಟೊ	ಡಡಡಡಡಿ	ಣುಣುಣುಣುಣೆ
ಟೇಟೇಟೇಟೇಟು	ಡೀಡೀಡೀಡೀಡೂ	ಣಣಣಣಣೆ
ತೊತೊತೊತೊತ	ಢಢಢಢೆ	ಣಾಣಾಣಾಣಾಣೇ

b) Alternate


ಟು


ಟಿ


ಟು


ಟಿ


ಡೊ


ಡ


ಡೊ


ಡ

Note: Following probes can also be used for therapy.

ಟೊಟಿಟೊಟಿ	ಡಡಿಡಡಿ	ಣಣೆಣಣೆ
ಟೂಟೇಟೂಟೇ	ಡೀಡೂಡೀಡೂ	ಣಾಣೇಣಾಣೇ
ತೊತತೊತ	ಢೇಢೋಢೇಢೋ	ಣುಣೆಣುಣೆ

c) Randomly alternating sequence



ಡೆ ಡೊ ಡೊ ಡೆ




ಡ ಡು ಡು ಡ

Note: Following probes can also be used for therapy.

ಟೊಟಿಟಿಟೊ	ಡಿಡಡಡಿ	ಣೆಣಣಣೆ
ಟೂಟೇಟೇಟೂ	ಡೀಡೂಡೂಡೀ	ಣಾಣೇಣೇಣಾ
ಠೊಠಠಠೊ	ಢೇಢೋಢೋಢೇ	ಣುಣಣಣಣು

6.5 Words

6.51 CVCV



ಟಾ ಟಾ ಟಾಟಾ

[14]



ಟೀ ಟಿ ಟೀಟಿ

6.52 CV1CV2


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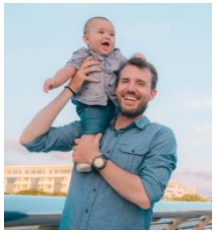
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6.53 C1VC2V


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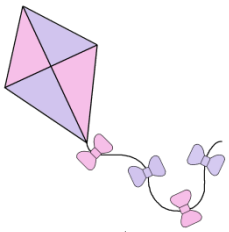
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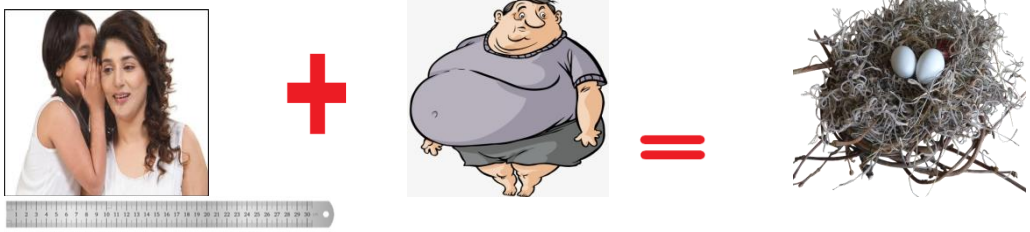


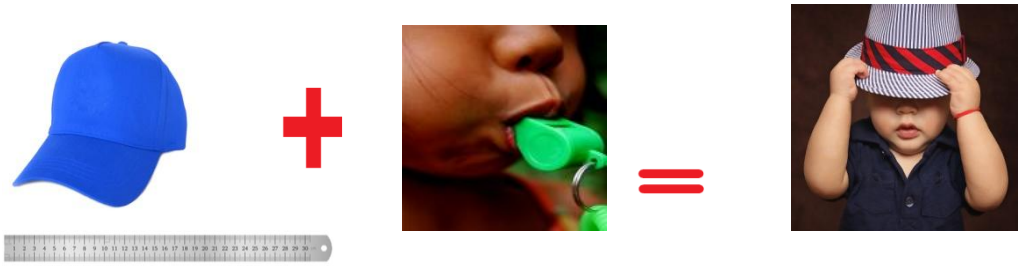
ಗೂ ಡು ಗೂಡು

ಗಿ ಣಿ ಗಿಣಿ

Note: Following probes can also be used for therapy.

ಪೇಟೆ	ಫೋಟೊ	ಬೂಟು
ದಡ	ಹಣ	ಬಾಣ

6.54 C1V1C2V2



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ಪೇ + ಡ = ಪೇಡ

ನೆ + ಡು = ನೆಡು

ಲೋ + ಟ = ಲೋಟ

ಮ + ಣೆ = ಮಣೆ

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Note: Following probes can also be used for therapy.

ತುಟಿ	ನೋಡು	ವೀಣೆ
ಟೇಪು	ಗಿಡ	ದೋಣಿ
ಬೋಟಿ	ಕಡಿ	ರಾಣಿ
ಪೇಟ	ವಡೆ	ಕೋಣ

6.55 CVCCV


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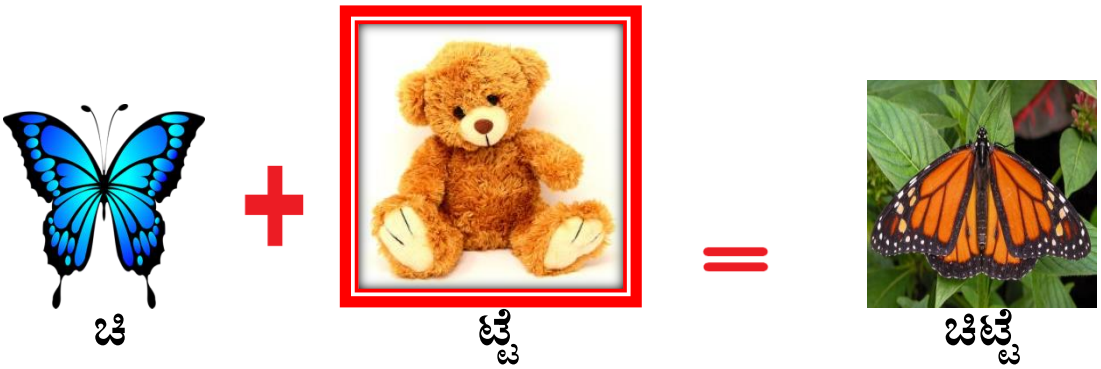


Note: Following probes can also be used for therapy.

ಪುಟ್ಟ	ದಡ್ಡ	ಬಣ್ಣ
ಮೊಟ್ಟೆ	ಲಡ್ಡು	ಸಣ್ಣ
ಜುಟ್ಟು	ಗುಡ್ಡೆ	ಬೆಣ್ಣೆ
ಬುಟ್ಟಿ	ಕಡ್ಡಿ	ಕಣ್ಣು

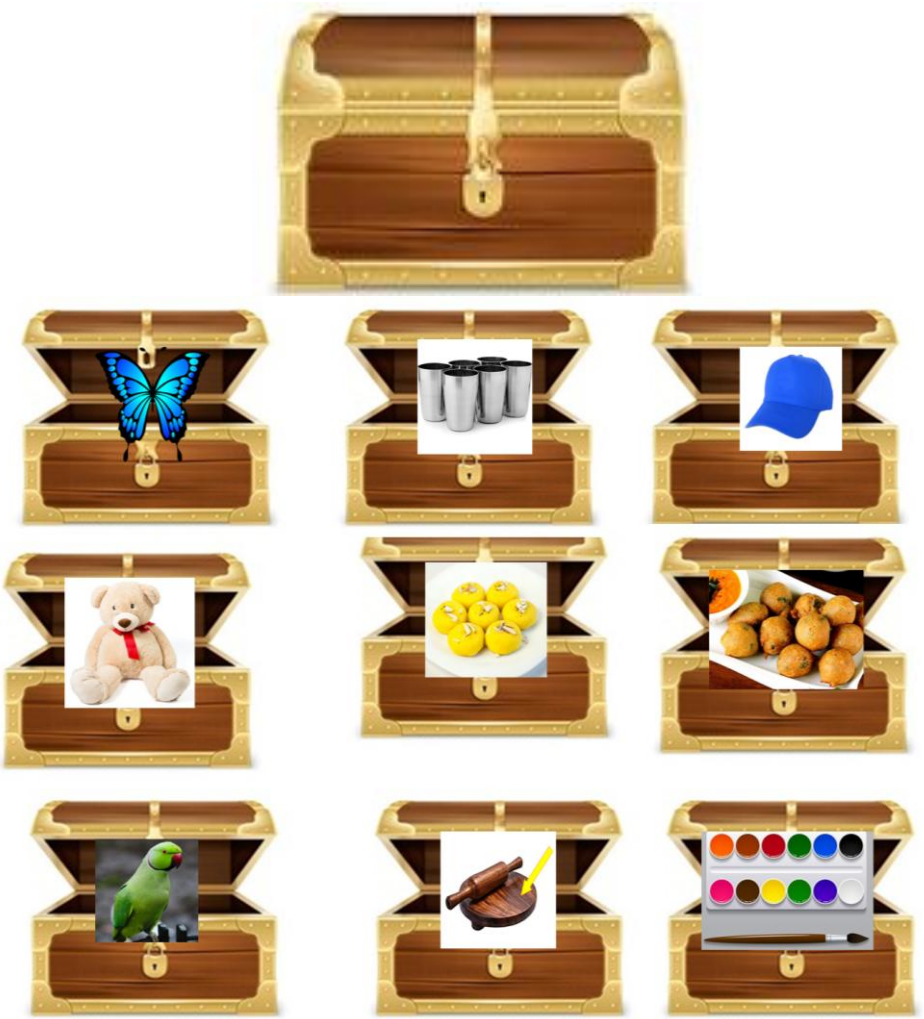
6.6 Play based activity

Activity 1: "Feed the hungry boy".

Instructions: Ask the child, "what all can be fed to the boy?" and encourage the child to name all the items which are edible from the given options.

Activity 2: "what's inside?!!"

Instructions: Present this activity in either a PPT form or carryout it using real box, items and pictures. Present the box in front of the child and encourage to ask for the box or to open it. Later encourage the child to name what is inside the box. Keep changing the items inside the box and present it to the child to retain child's interest in the activity.



Level 7

7.1 Fun with CV forms with consistency of consonant and vowel

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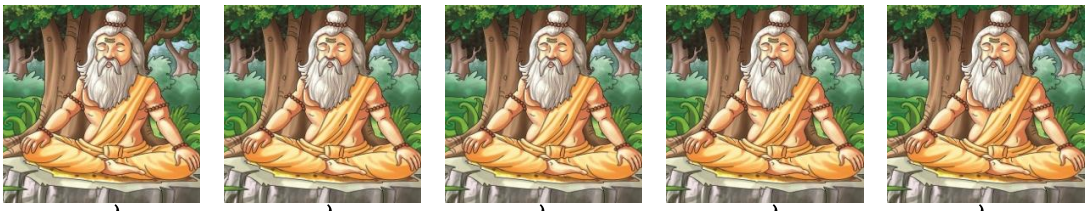

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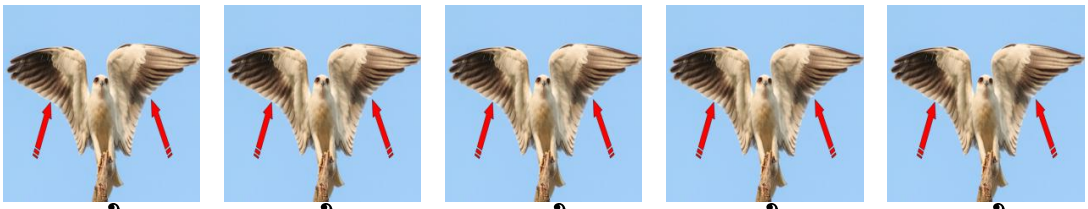

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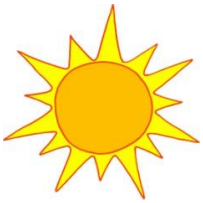
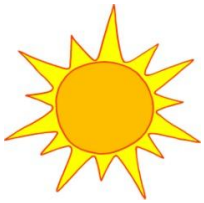
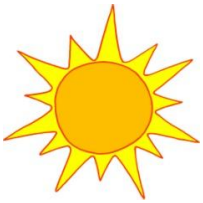
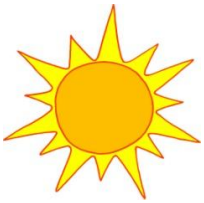
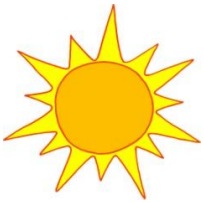


ಸು 

ಸು 

ಸು 

ಸು 

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7.2 Fun with CV forms with consistency of consonant and long vowel

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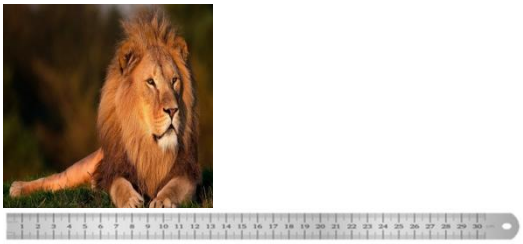

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Note: Other CV syllables with long vowels can be taught in similar way.

7.3Anticipating articulatory change in repeated phonetic sequences

a) Changes in the last syllable only

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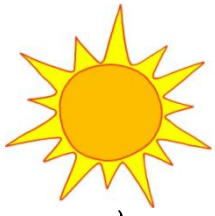
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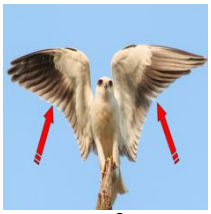
Note: Following probes can also be used for therapy.

ರೆರೆರೆರ	ಸುಸುಸುಸೊ	ಹಿಹಿಹಿಹ
ಹೆಹೆಹೆಹೊ	ಶಶಶಶೆ	ಸೊಸೊಸೊಸೆ

b) Alternate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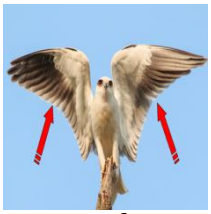
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Note: Following probes can also be used for therapy.

ರೆರರೆರ	ರುರೊರುರೊ	ಸುಸೊಸುಸೊ
ಹುಹಹುಹ	ಶಶೆಶಶೆ	ಶಿಶಶಿಶ

c) Randomly alternating sequence




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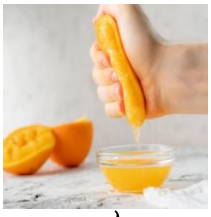


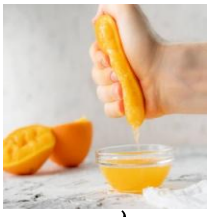

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Note: Following probes can also be used for therapy.

ರರಿರ	ರೊರೆರೊರು	ಸುಸೊಸೊಸು
ಸಸಿಸಿಸ	ಹಹಿಹಹೆ	ಶೆಶಶೆಶೆ

7.4Words

7.41 CV1CV2


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7.42 C1VC2V


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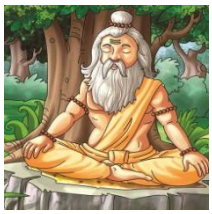
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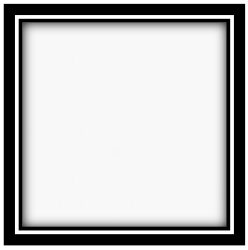
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Note: Following probes can also be used for therapy.

ಮರ	ಹರ	ದಾರ
ದೂರ	ಗುರು	ಗೆರೆ
ಕೆರೆ	ಸರ	ಸೂಟು
ಸಿಹಿ	ಸಿಟಿ	ನೂರು

7.43 C1V1C2V2


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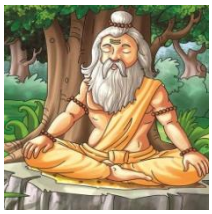
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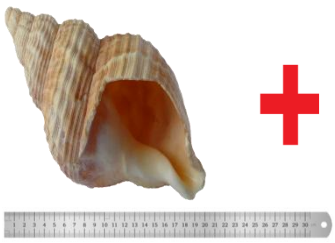
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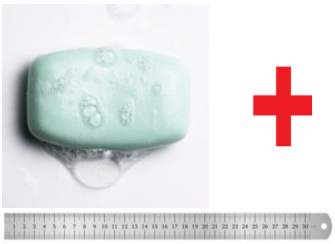
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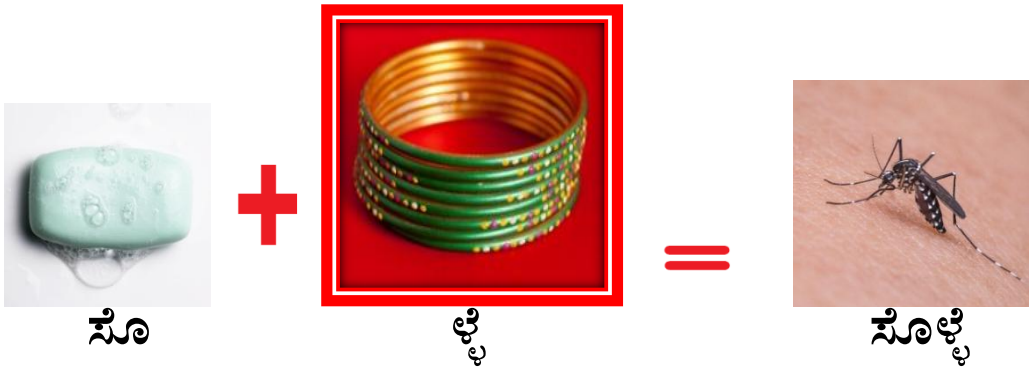
Note: Following probes can also be used for therapy.

ಮಳೆ	ಮೊಳೆ	ಹಳಿ
ಬಳೆ	ಕೊಳೆ	ತೊಳಿ
ಪುರಿ	ಸೀರೆ	ಜಾರು
ಕರು	ದಾರಿ	ಲಾರಿ
ನೀರು	ನರಿ	ಬೀರು
ಬರಿ	ಸೀತ	ಸೀಬೆ

7.44 CVCCV



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Note: Following probes can also be used for therapy.

ಹಬ್ಬ	ಹುತ್ತ	ಹಳ್ಳ
ಹಣ್ಣು	ಕಳ್ಳ	ಗುಳ್ಳೆ

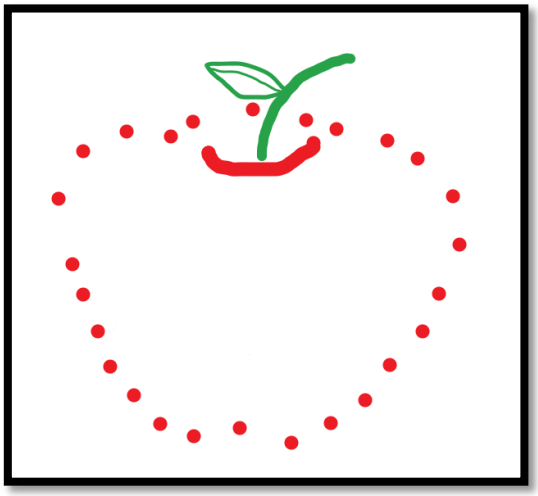
7.5 Play based activity

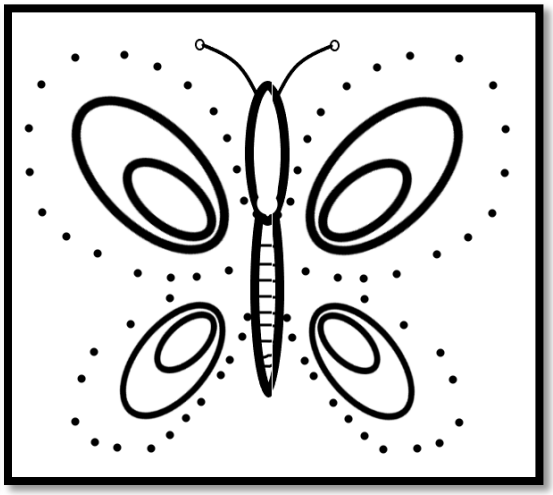
Activity 1: "Wheel of fortune"

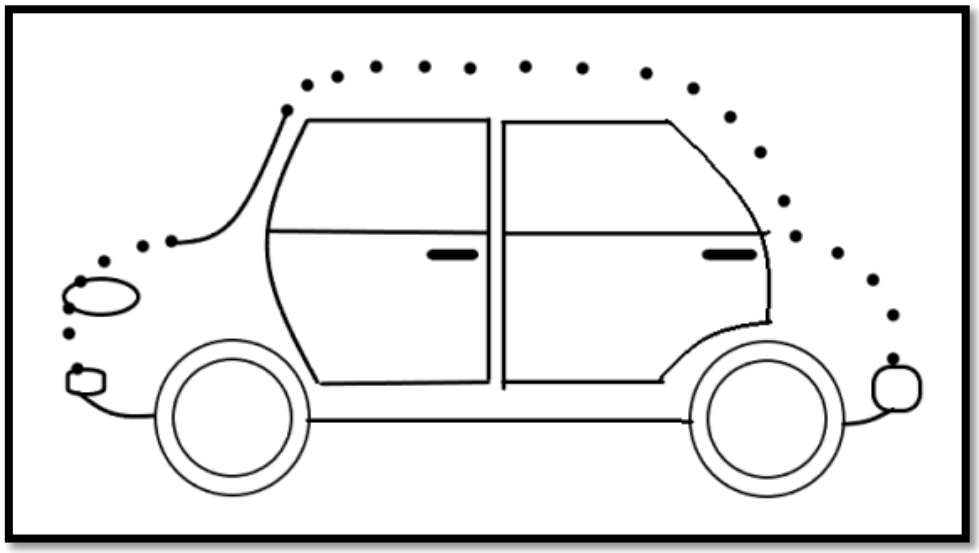
Instructions: Prepare a wheel with pictures as shown below. Encourage the child to spin the wheel and then name the picture which is being pointed by the pointer.

Activity 2: "Join the dots and color them"

Instructions: Introduce the following pictures along with colors and pencils. Encourage the child to name the one which he/she wants to join the dots ad colour them. Provide the items only when child asks for them verbally. Talk about the picture which the child is coloring and ask questions about the same.







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[1] www.pinterest.com

[2] www.dreamstime.com

[3] www.shutterstock.com

[4] www.freepik.com

[5] www.guiainfantil.com

[6] www.indianmart.com

[7] www.parenting.firstcry.com

[8] www.pinclipart.com

[9] www.justdial.com

[10] www.chotabheem.com

[11] www.marketgardenleeds.com

[12] www.theindianexpress.com

[13] www.amazon.com

[14] www.thoughtco.com

[15] www.istock.com

[16] www.padhuskitchen.com

[17] www.furthermore.equinox.com

Appendix II

RECORD FORM

Name: Age/Gender: PD:

DAILY RECORD FORM

Date	Target phoneme	Target level (highlight the targeted level)	No. of times probed	Responses		
				Correct responses	Distorted responses	Incorrect responses
		VC CVCV CV1CV2 C1V1C2V2 VCCV CVCCV				
		VC CVCV CV1CV2 C1V1C2V2 VCCV CVCCV				

MONTHLY RECORD FORM

Month: No. of sessions taken:

Target phoneme	Vowel in CV					CVCV	CV1CV2	C1VC2V	C1V1C2V2	VCCV	CVCCV
	a	i	e	o	u						

- Mention the number of trials (no. of times correctly produced/no. of times probed) under the target levels considered during the therapy sessions.

Appendix III

a. Consent form mailed to the validators prior to content validation.

From
M Kusuma
II MSc SLP
AIISH, Mysuru – 06

Date:

To

Forwarded through,
Dr. Swapna N
Associate Professor of Speech Pathology,
Department of Speech-Language Pathology,
AIISH, Mysuru -06

Sub: Expert opinion for **content validation** of the manual-reg.

Respected Sir/Madam,

I, M Kusuma of 2nd year MSc SLP of AIISH, have chosen **"Development of manual for training phonotactic structure in kannada speaking children with apraxia of speech"** as the topic for my dissertation, under the guidance of Dr. Swapna. N, Associate Professor of Speech Pathology, AIISH, which has to be submitted to the institute in part fulfilment for the degree of MSc SLP. As a part of the study, a manual is being developed for 2-6 year old children, by incorporating techniques and analogies used in Nuffield's Dyspraxia programme 3 (Williams & Stephens, 2004), an evidence based approach, and follows hierarchy proposed by Velleman (2002) for phonotactic therapy to train phonotactic structure in Kannada and to aid and improve in planning, programming and sequencing of speech sounds. Each sounds and/or syllables of Kannada are associated with particular picture and these pictures used in a particular sequence to aid in production of targeted words and also in training the phonotactic structure of Kannada.

I request you to kindly go through the content of my manual and rate it on a 3 point rating scale on the following parameters described below and give your valuable suggestions about the manual.

- **Appropriate:** Are the phonemes appropriately associated with the pictures?
- **Familiarity:** Are the pictures familiar to the children in the age group of 2-6 year old children?
- **Colour & appearance**: Are the picture stimuli appropriate in terms of colour and appearance?
- **Iconicity:** Does the picture stimuli appear to be recognisable and representational?
- **Stimulability:** Are the stimulus materials appropriate to elicit responses from children?
- **Trainability:** Can the stimuli be used for intervention purposes.
- **Likeability:** Will children like the stimuli images?

Thanking you in anticipation,

Yours faithfully,
M Kusuma

b. Sample content validation questionnaire for validating the format of the manual.

Depiction of long vowels: *

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	Poor	Fair	Good
Appropriate	☐	☐	☐
Stimulable	☐	☐	☐
Trainable	☐	☐	☐

Depiction of Aspirated sounds *

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	Poor	Fair	Good
Appropriate	☐	☐	☐
Stimulable	☐	☐	☐
Trainable	☐	☐	☐

Depiction of word production *

	Poor	Fair	Good
Appropriate	☐	☐	☐
Stimulable	☐	☐	☐
Trainable	☐	☐	☐

Depiction of Geminates *

	Poor	Fair	Good
Appropriate	☐	☐	☐
Stimulable	☐	☐	☐
Trainable	☐	☐	☐

Does the subsections in the level follow simple to complex hierarchy? *

- ☐ Yes
- ☐ No

c. Sample content validation questionnaire for validating pictures associated with the syllables.

/gi/ *

	Poor	Fair	Good
Familiarity	☐	☐	☐
Appropriate	☐	☐	☐
Stimulabilty	☐	☐	☐
Trainability	☐	☐	☐
Colour & appearance	☐	☐	☐
Likeability	☐	☐	☐