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THERAPY OUTCOME OF COMBINED TREATMENT APPROACH IN CHILDHOOD APRAXIA OF SPEECH (CAS)

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ABSTRACT

Background: *Childhood apraxia of speech (CAS) is a neurological childhood speech disorder in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits. CAS is a controversial disorder in terms of diagnosis and intervention approaches.* ***Purpose:*** *Due to heterogeneity of children with CAS, a speech language pathologist faces methodological challenges to administer any single therapy approach. Absence of any single effective CAS oriented therapy approach leads to a critical need for research on a use of reliable and effective treatment protocols together through eclectic approach and its validation.* ***Objectives:*** *To assess the effectiveness of Nuffield dyspraxia program (NDP) with incorporation of melodic intonation therapy (MIT) and multisensory approach for CAS.* ***Methods:*** *A Hindi speaker child age 8years/male had difficulties in achieving initial articulatory configurations and transitioning into and out of these configurations during speech and non-speech task. Single subject experimental design with multiple baselines across behaviours e.g. non speech motor task, speech production abilities, prosody, speech perception, language skills was used. NDP therapy steps were followed along with the use of MIT and multisensory input.* ***Results:*** *After 1hour sessions, twice a week for 7 months of treatment, improvement in automaticity and flexibility of articulatory movement was found in non-speech and speech motor task. Child achieved 80% target stimuli with 90% accuracy on naming task (Appendix-I). Language domains i.e., Syntax, semantics, and pragmatic was rated as Brown stage 3, 5 year and 5-7years respectively. These language domains were also evaluated on 18^{th}, 36^{th} and 54^{th} session of treatment.* ***Conclusion:*** *Incorporation of these approaches would help in tailor made therapy plan and its replication would increase its external validity.*

Key words: CAS, Nuffield dyspraxia programme, MIT.

INTRODUCTION

Childhood Apraxia of Speech (CAS) is, according to the definition stated by the American Speech-Language-Hearing Association (ASHA, 2007), "…a neurological childhood speech 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). It 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 spatial-temporal parameters of movement sequences results in errors in speech sound production and prosody."

CAS is the most controversial childhood developmental disorder, described as an unfolding and changing condition; its underlying causes(s) remain heavily debated (Bowen, 2011). The range of problem experienced "unfold'' as the child progress and consecutively makes any intervention program difficult to get implemented due to methodological challenges. Recently consensus has been reached that only three features across these domains (i.e., non-speech oral motor function, motor speech function, speech sounds and structures, prosody, language, phonemic awareness/ metalinguistic skills, and literacy) have diagnostic validity: (1) inconsistent error production on both consonants and vowels across repeated productions of syllables or words, (2) lengthened and impaired co-articulatory transitions between sounds and syllables, and (3) inappropriate prosody (ASHA, 2007). At present, there is a lack of agreement in the clinical and research community about how to diagnose CAS (ASHA, 2007).Thus, further research is critically needed in developing consensus on the specific diagnostic features of CAS and developing reliable and valid tools for assessing the particular diagnostic features of interest and the severity of the disorder. Improvements in diagnosis will have a number of impacts on establishing an evidence base for treatment in this field.

In CAS, motor learning behaviors remain affected along with non-speech tasks, speech motor tasks, melody (prosody) of speech, speech production abilities, speech perception, language skills. They have significant speech impairments due to an inability to control placement and timing of lip, tongue and vocal movements. These impairments result in inconsistent productions of the same words, difficulty in sequencing speech sounds together to form fluent words and sentences and impairments of the melody (i.e. prosody) of speech. Thus, there is a need of therapy approaches that focus on speech output. However, it is acknowledged that some children need to work on input skills too and it is recommended that output and input skills should be worked on together. Presently, there are no any specific approaches which can facilitate all these domains together. So, primarily Nuffield dyspraxia program (NDP) developed by Williams and Stephens (2004) was used along with melodic intonation therapy (MIT) and multisensory approach to understand its success during CAS intervention. Nuffield dyspraxia program is the only published therapy approaches specifically for CAS and is used widely by speech language pathologist in the UK and overseas. It offers a systematic approach to the assessment and treatment of childhood apraxia of speech and is particularly suitable for children aged 3-7 years. It offers a non-prescriptive approach that gives SLPs the flexibility to plan individualized therapy programme. Theoretical bases of this program state that motor learning is complex and hierarchical; one needs to perform frequent and systematic practice to master foundation levels before progressing to harder and, more complex speech patterns.

This approaches focuses on cueing systems e.g., cued articulation, orthographic cues and diagrammatic cues. As per protocol it uses the concept of auditory discrimination (different to traditional dyspraxia therapy approaches where it is considered that auditory discrimination is not an area of difficulty for children with CAS), phonological awareness and meaningful minimal pair contrasts (NDP is not specifically designed to focus on these skills, but since the aim of therapy is to build a comprehensible speech and contrastive speech system at each level of word complexity). Oro-motor programmes (NDP, 2012) include guidance on eliciting movements required to produce specific features of articulation. Although oro-motor skills may be introduced in isolation, but it is linked to speech sound production and therefore NDP is different from oro-motor approaches which are purely designed to develop oro-motor skills (Williams and Stephens, 2004).

In literature there are several studies which suggest that combination of different therapy approaches as an eclectic approach shows more improvement than single approach. Dynamic temporal and tactile cuing (DTTC) is a variation of integral stimulation that was developed by Strand and Skinder (2000) for nonverbal children. This combined treatment approach aimed to facilitate more independent and automatic speech skills but DTTC is more effective when it is used in conjunction with tactile, gestural, and prosodic cues or melodic intonation therapy techniques (Bowen, 2013).

Few researchers show that the neural pathways for language and music are not entirely separated and melodic intonation therapy (MIT) capitalizes on this overlap. Helfrich-Miller (1994) adapted the MIT for children with apraxia (CAS) to take advantage of the musicality of language and to use music to support utterances. Korpilahti (2011) also used a combination of therapies i.e. adapted MIT and Touch-cue method (TCM) for a child with suspected CAS. Adapted MIT was given first, and then TCM and it was found that participant made significant gains after TCM and the child started correctly sequencing novel words when they were related to the

practice sounds after TCM therapy. Although, MIT would not be a therapy to use with every child, it could be a very useful technique for those who are comfortable with singing and are able to do it, but for those who are uncomfortable with singing, MIT would be more stressful and less therapeutic than intended (De Bruijn, 2011). MIT does not work universally enough to be the main focus of treatment for CAS. Its failure is evident due to the involvement of only auditory input by which children with CAS have already been exposed to instead of teaching them what they need to know to produce speech. It might also occur due to the lack of multisensory inputs or an ill-chosen input along with MIT. The treatments that include multi sensory input appear to be more effective than approaches that use a single sensory modality. Fish (2011) also focused on therapy approaches which should concentrate on establishing increasingly complex articulatory sequences, repetitive practice required to establishing automaticity of speech motor movements, start from strength of a child and multisensory cueing system which is needed to increase motor planning and motor sequencing. Cues should be faded systematically to facilitate spontaneous production.

Literature reviews demonstrates that currently there are very few well-controlled studies which help in concluding the efficacy of treatment for the heterogeneous CAS population up to some extent and calls for speech language pathologist (SLPs) working in this area to design better studies. Absence of any single effective CAS oriented therapy approach is a sort of therapeutic a challenge for SLPs to deal with CAS. This suggests a critical need for a research pertaining to use of reliable and effective treatment protocols together through an eclectic approach and its validation. This paper has aimed to assess the effectiveness of NDP with incorporation of melodic intonation therapy (MIT) and multisensory approach on a child with CAS.

METHODS

Participant: An urban based Hindi speaker child age of 8 years / male with a chief complaint of unclear speech. Child had history of delayed motor and speech-language developmental milestones but there was no significant medical history. Hearing and vision were reported to be normal but academic performance was reportedly poor in a regular school. He had stimulating and supportive family environment but had not attended any other therapy earlier.

Design: A single subject experimental design with multiple baselines across behaviors.

Assessment process and Assessment

Assessment process: CAS diagnosis was made as per ASHA (2007) criteria as well as Strand's 10 point checklist. Child met recommended criteria for diagnosis. Diagnosis was verified by the second author blinded to the first author decision.

Assessment: Overall speech and language assessment suggestive of difficulties in non speech motor task, speech production abilities, prosody, speech perception, language and meta-linguistic/literacy skills. During assessment, core deficits were found in timing, programming and sensory motor / spatial temporal coordination. Perceptually voice was normal. Speech and language was delayed. Speech intelligibility was 4 i.e. understood by family members only
(Gordon-Brannan and Hodson, 2000). Alternate motion rate (AMR), Sequential motion rate (SMR) and Non-word repetition (NWR) was severely affected. Baseline was established and therapy goals were planned on the basis of assessment of connected speech, prosody, speech motor task and nonverbal oral movement control and sequencing tasks (except meta-linguistic/literacy skills, which was not focused in this paper since it need separate descriptive study). (Refer Table 1, 2, 3, 4, 5 for baseline of all tasks). Due to heterogeneous nature of CAS, improvement during speech-language therapy sessions were observed finely for each 18 sessions as initial, middle and final phase.

Treatment

Nuffield dyspraxia program (NDP)

This program was designed to meet the needs of children with severe speech disorders and specifically those with significant difficulty with motor program/programming and motor planning stages of the speech processing model. Rational of using it that it focuses on building up articulatory skills, in small graded steps, through frequent systemic practice. It uses a motor skills learning approach and sees articulation as a complex hierarchical motor skills. Skills are established by means of frequent repetition elicited by cues and reinforced or modified with the support of specific follow up. It provides therapy advice and guidance, but it is not prescriptive. SLP has the flexibility to plan an individual therapy programme for a specific child using the materials. It is based on frequent, repetitive practice at each stage to learn and establish new skills. However it does not provide guidance on the frequency or intensity of interval. Generally, the programme will be delivered in one to one therapy sessions with follow up activities carried out by parents or assistant as a home practice by using different naturalistic communication treatment strategies which is paramount.

NDP principles were incorporated with multisensory approach and melodic intonation therapy. Frequency of the therapy was set twice in a week for 1hour/ session for 7 months. Treatment goals were focused to facilitate - (1) Learning of a new speech pattern or incorporation of an old pattern of sound into a new more complex context, (2) Naming abilities of different real word or picture stimuli independently with 90% accuracy, (3) Short term memory and auditory perceptual-motor coordination, (4) Learning and use of sound combinations and supra segmental features, (5) Non speech motor abilities through multisensory cues and (6) Overall speech intelligibility. The overall focus of treatment was to improve speech production and consequently better intelligibility and comprehensibility through the facilitation of individual's ability to assemble, retrieves and executes motor plans for speech.

Procedure

Five sounds or real word stimuli were chosen per goal (Appendix-I). Selection of these stimuli was done on the basis of most familiar word in child's his environment. Monosyllable, bisyllable and multisyllable wordlists with 20 most familiar words in each wordlists were given to the child's mother and she was asked to select any five most frequently used words in child's natural settings. On the basis of difficulty level of stimuli, three wordlist with five items in each have been made. All goals were incorporated with verbal instruction, modeling, articulation, visual tactile cue to guide tongue/lip placement and pictured stimuli to guide children in modifying their production to say the sound or selected stimuli accurately. Immediate feedback was provided after every production attempt. When the production was accurate, child was asked to repeat the stimulus item thrice to help consolidate new motor plans. The child was supposed to say each stimulus item with 90% accuracy out of at least 12 trials without modeling or cueing. Production accuracy for the acquired word(s) was checked frequently to ensure maintenance of skill. If performance was found deteriorated, it was re-introduced into the set of treatment words and the newest item removed to maintain the same number of treatment words at all times. Once 5 stimulus items were acquired for a given goal, treatment was move up the hierarchy to the next level even though words of higher hierarchy have been introduced from initial phase for familiarity. Auditory discrimination, perception tasks and MIT steps of adapted MIT for CAS by Helfrich-Miller (1994) were followed along with multisensory inputs. These approaches were incorporated simultaneously during all practice and novel tasks. Speech intelligibility and accuracy of productions was documented to track percent accuracy for each stimulus item after 18 sessions through inter-judge and intra-judge reliability score. SLP with more than four years of experience in childhood communication disorders were included as Judges.

RESULTS AND DISCUSSION

After seven months of therapy along with intensive home practice, performance on non-speech and speech motor task suggested improvement in automaticity and flexibility of articulatory movement. Discrete findings for multiple behaviors i.e. non speech and speech motor task, prosody, speech production abilities, speech perception, language skills have been monitored during initial phase, mid phase and final phase of therapy. Eighteen sessions were allotted to each phase.

Table 1: *Task for Assessing Non Verbal Oral Movement Control and Sequencing*

Sl.no	**Task**	**Baseline**		**Initial Phase**		**Middle phase**		**Present/Final phase**	
		C	**I**	**C**	**I**	**C**	**I**	**C**	**I**
1	Cough		2	2		3		4	
2	Click your tongue		1		3		4		4
3	Blow	2		2		3		4	
4	Bite your lower lip		2		2		3		4
5	Puff out your cheeks		1		2		3	4	
6	Smack your lips		2	2		3		4	
7	Stick out your tongue	3		3		4		4	
8	Lick your lips		3	3		4		4	
9	Smack your lips and then cough		1		2	3		3	
10	Bite your lower lip and then click your tongue		NR		1		2	3	

Abbreviation used: C= command, I= imitation. (Modified from Darley FL. Differential diagnosis of acquired motor speech disorders. In Darley F, Spriestersbach D, editors; Diagnostic methods in speech pathology,ed2,new York,1978,Harper & Row).

1: refers; Inaccurate or only partially accurate; important component missing or off target; **2:** refers; accurate after trail & searching movements; **3:** refers; accurate but awkwardly or slowly produced; **4:** refers; accurate, immediate, and effortless; **NR:** No response

Initially child's performance on non verbal oral movement control and sequencing tasks either through verbal or non verbal command, were mostly inaccurate and awkward. Crary and Anderson (1991) also noted that children with CAS in comparison to their peer group has slow rate and less accurate performance on sequential task related to hand and facial movements. It was found that incorporation of oro-motor along with and multisensory approaches would help in facilitating more accurate, immediate and effortless non verbal oral movement control and sequencing task in comparison to inaccurate and off target baseline response. These findings reflect the phenomenon of differentiation and refinement, which lead to gradual acquisition of independent control over individual articulators (lips, different portions of the tongue). Consequently, specialized configuration and sequencing of articulatory posture without extraneous movement got facilitated despite of fairly strong evidence that addresses non-speech tasks does not result in any generalization to speech. In CAS there is difficulty with the specification of movement parameters required to produce articulatory configurations and constrictions to make those sounds. Therefore it is helpful to think in terms of treating movement sequences or transition rather than phonemes initially, during therapy.

Table 2: *Responses* on *Speech Motor Tasks*

Speech Motor Behaviours	**Baseline**	**Initial phase**	**Mid phase**	**Present /Final phase**
Maximum repetition rate (MRR) for single syllables or trisyllabic sequences (e.g., /pΛtΛkΛ/ etc.)	Severely affected	Unable to combine and produce	8 times with fair coordination in 16 sec.	20 times with proper coordination in 28sec
Alternate motion rate (AMR)	Severely affected	/p/: 6 in 20 sec /t/: 8 in 20 sec /k/: 8 in 20 sec	/p/:18 sec. /t/ : 20 sec /k/:17sec	/p/:12 sec /t/:15 sec /k/:13 sec
Maximum sound prolongation of vowels	Severely affected	8 sec	12 sec	16 sec
Non word repetitions (NWR)	Severely affected	30 % stimuli repeated accurately	50% stimuli repeated accurately	80% stimuli repeated accurately

Table 2 shows that speech motor behavior of the participant has been improved from minimal score to average score in comparison to baseline status on maximum repetition rate (MRR), alternate motion rate (AMR), vowels prolongation, and non word repetition (NWR) tasks after usage of eclectic treatment approach. Lewis et al. (2004) found significant differences between preschool and school-age children with CAS and matched children with non-CAS speech delay in their ability to repeat non-words and multisyllabic words, the CAS group performed more poorly. Square (1999) highlighted that the most frequently used categories of treatment methods for CAS include, "tactile-kinesthetic facilitation, rhythmic and melodic facilitation, and gestural cueing". Speech motor tasks especially AMR and SMR were found properly coordinated in terms of range, rhythm and accuracy but slower in rate in comparison to normative data. These tasks require fast and coordinated motor execution. Velleman (2003) also stated that specific speech task like repetitive syllable or DDK are troublesome for children with CAS due to poor spatial-temporal coordination which dominate speech motor control development. Thus, multisensory and MIT approaches would be effective for development of speech motor coordination. Bose & Square (2001) found that tactile-kinesthetic treatment techniques attempt to help children with CAS to obtain better oral movement control by direct motor manipulation of the structures used for speech and tactile cues directed at appropriate locations.

Table 3: *Rating Of Deviant Speech Characteristic- Prosody*

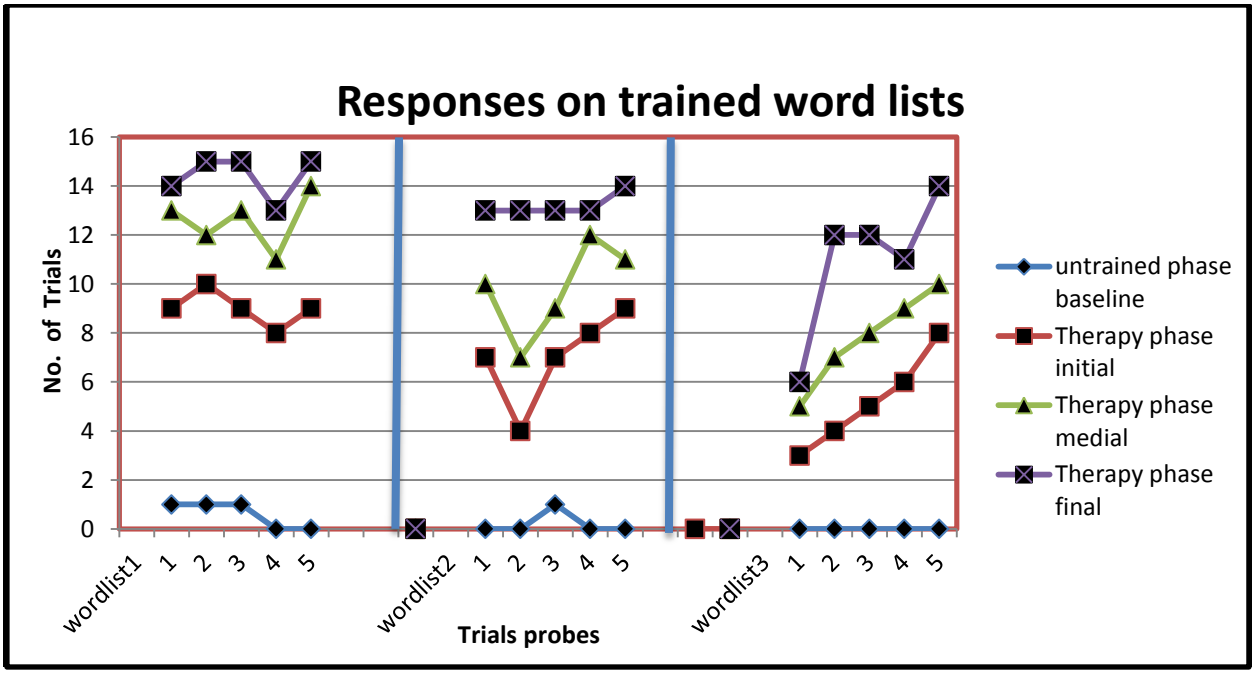
Sl.no.	Prosodic characteristics	Baseline	Initial phase	Mid phase	Present/Final phase
1	Rate	3	2	1	1
2	Short phrases	4	4	2	1
3	Increased rate in segment	3	3	2	1
4	Increased rate overall	4	4	3	2
5	Reduced stress	3	2	1	1
6	Variable rate	3	2	2	1
7	Prolonged intervals	4	4	3	2
8	Inappropriate silence	3	3	2	1
9	Short rushes of speech	4	4	3	1
10	Excess and equal stress	3	3	1	1

Ratings: 0=normal, 1=mild, 2=moderate, 3=marked, 4=severely deviant (Modified from dimensions used in Mayo Clinic dysarthria studies, plus additional features that may help characterize dysarthria.)

As table 3, shows that child's speech had marked deviant prosodic features. There was severely deviant prolonged intervals within and between words, had slow rate of speech due to the difficulty in timing and programming. Ripley et al. (1997) also stated that child with CAS possesses symptoms like difficulty with prosodic feature of speech; sequencing sounds for words and sentences, difficulty with length and complexity in sentences and inconsistent speech production. Till final phase of therapy it was found that usage of Nuffield program, MIT and multisensory approach, altogether tend to increase child's ability to transit one articulatory posture to next smoothly with the emphasis on supra segmental aspects too. Martikainen (2011) also assessed the effectiveness of the combination of two motor intervention methods, Melodic Intonation Therapy (MIT) and the Touch-Cue Method (TCM), on children with CAS and suggested that the combination of MIT and TCM is an effective way to show substantial gains after therapy. Velleman (2003) stated that explicit practice of various intonations and stress pattern for young children through modeling without calling attention to the nature of pattern and for older children through metalinguistic awareness which would facilitate awareness and production of supra-segmental features.

Groenen (1996) also found that children with CAS have poorer discrimination than the control group, suggestive of affected auditory processing. Analysis of performance on discrimination and articulation task of children with CAS suggested specific relation between the degree to which auditory processing is affected and the frequency of place-of-articulation substitutions in production. It was indicated that there is interdependence of perception and production. Thus, the use of perceptual tasks has significant clinical value. Above mentioned wordlist was used for naming task after achievement of 90% accuracy on perceptual task.

Figure 1: Verbal Responses on Trained Word Lists



To facilitate speech production through auditory perceptual motor coordination, firstly, trained wordlists stimuli (appendix I) were used for spoken word-picture matching task before introducing naming task. It helps in facilitating speech perception ability which in turn enhances child's self monitoring and self correction skills during any speech task.

Figure 1, shows at baseline mostly 0 or 1 correct responses out of 15 trials were found for all three word lists. In initial phase of therapy immediate feedback, modeling, visual tactile cues were given till single production was accurate. Later, child was asked to repeat stimulus items to help consolidate new motor plans.

Acquisition of accuracy of words of wordlist I, II, & III are poor for phase one and consecutively better for phase II and III. For each word list initial phase has low correct trial score. Performance on word list 3 at initial phase is poor in comparison to wordlist 1 and 2 due to complexity of words included in this wordlist (as shown in fig.1).

Uniform trend of response were observed for all word list during therapy phases with usage of NDP, MIT and multisensory approach. On word list I, II & III, 4/5, 5/5 and 3/5 respectively, items have reached the criteria 90% accuracy out of at least 12 trials without modeling or cueing. All word lists were assessed in each phases to ensure maintenance and more accuracy. Child was not able to achieve 90% accuracy criteria for /ʧʰtʌ:/, /dʌrwʌ:ʤ ʌ:/ and /tʌmʌ:tʌr/ trained stimuli. These words were consisting of alveolar and alveo-palatal sound with stop and affricate manner of articulation.Words that required motor sequencing of sounds produced in differing places in the oral cavity proved most challenging for child with CAS.

Later in therapy, fifteen untrained items (appendix- I) were introduced and asked to repeat without any cue. Child has achieved 90% accuracy criteria on 86% stimuli. It indicates shifting of motor learning behaviors from trained and familiar task to untrained unfamiliar tasks. Edeal (2008), studied two children with moderate to severe CAS and concluded that "frequent and intense practice of speech sounds in the context of integral stimulation therapy resulted in faster acquisition of the targets, better in session performance, and more generalization to untrained probe words". Presently, child's responses on naming tasks, either for familiar or unfamiliar stimulus are nearly accurate and intelligible for familiar and unfamiliar listener.

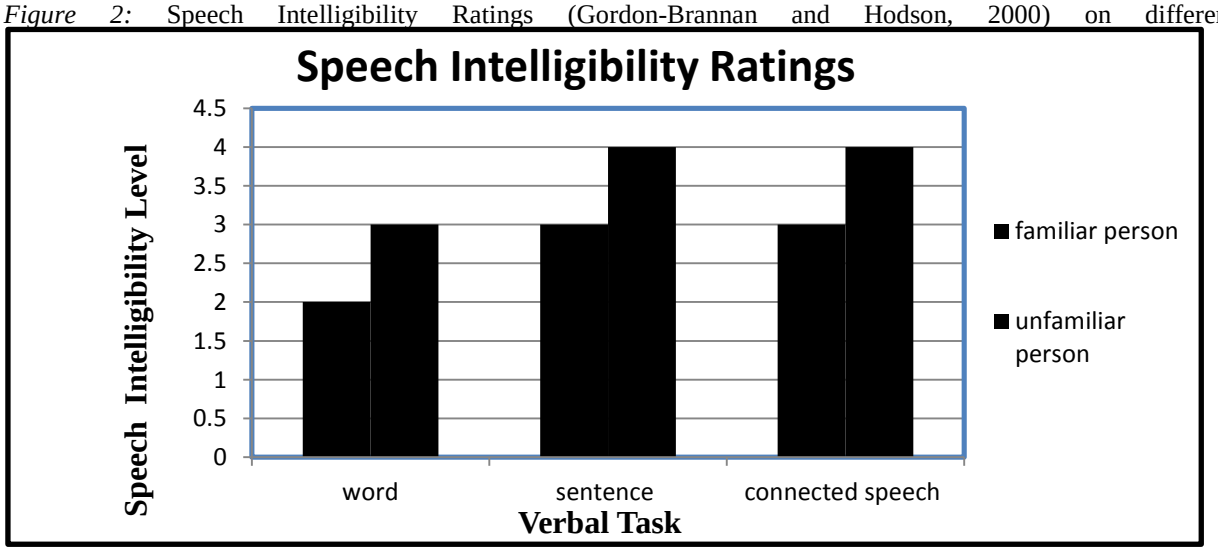
Table 4: *Rating Of Connected Speech Production Tasks*

Sl.no	CONNECTED SPEECH	BASELINE	INITIAL	MEDIAL	PRESENT/ FINAL
1	General conversation	5	5	6	9
2	Daily activity	4	5	9	10
3	Topic description	5	6	13	14
4	Story retelling	5	5	9	10
5	Narrative event	5	6	9	10

A numeric code has been adapted from the ***Porch Index of Communicative Ability*** **(Porch, 1967)**.

Score	Category	Dimensional Characteristics
16	Complex	Accurate, responsive, complex, prompt, efficient
15	Complete	Accurate, responsive, complete, prompt, efficient
14	Distorted	Accurate, responsive, complete or complex ,prompt, distorted
13	Complete-delayed	Accurate, responsive, complete or complex, delayed
12	Incomplete	Accurate, self-corrected
11	Incomplete-delayed	Accurate, responsive, incomplete, prompt
10	Corrected	Accurate, self- corrected
9	Repeated	Accurate, responsive, complete, prompt
8	Cued	Accurate, responsive, complete, prompt
7	Related	Inaccurate, almost accurate
6	Error	Inaccurate attempt at task item
5	Intelligible	Comprehensible, but not an attempt at the task item
4	Unintelligible	Incomprehensible, but differentiated
3	Minimal	Incomprehensible and undifferentiated
2	Attention	No response, but subject attends to the tester
1	no response	No response, no awareness of task.

Figure 2: Speech Intelligibility Ratings (Gordon-Brannan and Hodson, 2000) on different verbal tasks



Measurement of intelligibility based on frequency of occurrence of misarticulation (Gordon-Brannan and Hodson, 2000)

Table 4 and Fig. 2 reveal that lack of timing and programming of motor coordination and its execution for content words results poor performance on connected speech task. Initially, performance of child on connected speech was sort of rejection or stated inability to respond to mostly self corrected articulatory response with few distortion in speech sounds. Turnbull (2012) also stated that student with CAS may able to say the individual sounds required for speech in isolation syllables, but they cannot produce them in longer word and sentences. In association with other treatment approach, MIT target a child's impaired speech rhythm (coordination) or inappropriate stress through simple rhythmic repetitions of single sounds and syllables. Rhythmic (prosodic) approaches, such as melodic intonation therapy (Helfrich-Miller, 1984, 1994), use intonation patterns (melody, rhythm, and stress) to improve functional speech production. Helfrich-Miller (1994) reported that subjects with CAS demonstrated increased speech intelligibility and fewer articulation errors following treatment with MIT.

Square (1994) also suggested that methods that highlight movement sequences and methods that heighten the melodic line and slow rate have gained the greatest favor in the treatment of children with CAS and adults with acquired apraxia of speech. Along with this motor learning theory also demonstrates that a high degree of direct practice leads to the transfer and generalization of sequential motor plans needed for correct speech production.

At the broader level of speech production, standardized and informal outcomes were measured as a functional gain in communication e.g. improvements noted in the intelligibility of spontaneous speech as rated by blind raters and through parental questionnaire.

Table 5: *Assessment of speech and language skills*

Test battery	Baseline	Present status/Final phase
PAT-Hindi version (Developed as UNICEF project, AYJNIHH, Mumbai)	Substitution=12,PCC=55.5% (Moderately severe)	Substitution=9, PCC=70% (Mild-moderate)
Linguistic Profile Test-Hindi version (Developed as UNICEF project, AYJNIHH, Mumbai)	Semantic: R:33.3% , E:33.6%,Total:33.3% Syntax: R:36.7%, E:30%, Total:33.3% Combined Language: R:34.8%, E:31.7%, Total:33.3%	Semantic:R:75%,E:36.6%, Total: 57.6 Syntax:R:83%, E:63%, Total:73.33 Combined Language:R:72%, E:50%, Total : 65.07%
Milestones for early communication development (Chart reference: Paul, R. (2001).Language disorders from infancy through adolescence, 2nd ed.)	Pragmatic:18-24 months Syntax: Brown stage 1 Semantic: 24-30 months	Pragmatic: emerging 48-60 months Syntax: Brown stage 3 Semantic: emerging 48-60 months Phonology: Speech is 70-75%, ability to produce rhyme emerge.

Abbreviation: PAT= Photo articulation test; PCC= Photo articulation test; R=Reception; E=Expression

During speech and language assessment it was found that presently, the most prominent consonant error patterns were substitutions, occasional instances of metathesis, speech sound distortions and prolongations. As it is known that there is heterogeneity among children with CAS due to the co-occurrence of co-morbid difficulties (e.g. language deficits) which may be secondary to the primary deficits. So, intervention program should also focus on other language deficits along with primary deficits of children with CAS.

Iuzzini & Forest (2010) also approved the impact of a dual treatment approach that included stimulability training protocol (STP) paired with a modified core vocabulary treatment (m CVT) on the speech sounds production of children with CAS. He found that all children evidenced inventory expansion (average of five sounds) and increased PCC (average of 20% increase), and three of the four children evidenced increased consistency in sound use.

Thus, in this study rather than focusing on any specific domain during intervention process, all major domains have been discussed except metalingusitic/literacy since, it needs extensive discussion separately. Within each of these domains, reference is made to core deficits in timing, programming, and sensorimotor coordination. It was observed that Nuffield dyspraxia program with incorporation of MIT and multisensory approach are effective in reducing core deficits or its severity and proves better improvement in speech-language aspects of children with CAS in comparison to any single treatment approach.

There is also a lack of consensus regarding relevant outcome measures for this population. If we do not understand how the disorder presents pre-treatment, how can we anticipate what may change and what we should measure post-treatment? Current CAS intervention studies have largely focused on impairment- based outcome measures only. Future systematic treatment efficacy studies should consider more functional impacts of the treatment beyond the level of impairment (i.e. activity and participation), the efficacy of treatment dependent upon differing communication environments (i.e. incorporating more naturalistic settings for the child with CAS such as home and school), and should consider ratings made by the child's parents or peers and not just the clinician (WHO, 2002).

It is understood that there is a need for improvement in diagnosis which may help to alleviate the apparent hesitance of authors in systematically and explicit reporting assessment and treatment data in intervention studies. Clarity and explicit reporting is required for all areas of assessment and treatment of CAS however, author should specifically report on: exactly what assessment were used, which treatment protocol and principle/motive behind its usage, what was the baseline diagnostic and present features of participants, exactly what treatments were provided (treatment goals) and how (i.e. nature, duration and intensity), what and how outcomes were measured(formal or informal tests) and what the resulting outcome was. Systemic reporting of assessment and treatment details is crucial to assist clinicians in interpreting or generalizing study approaches and findings. Systematic reporting is also critical in enabling other researches to replicate existing studies to determine whether the original intervention findings were robust.

CONCLUSION

CAS is a controversial disorder in terms of clinical findings, low prevalence and effective intervention program. It is difficult to conduct large scale studies on children with CAS, since its signs not only varies among children with CAS rather it also changes with maturation. Thus, during intervention instead of sticking to a single approach we can incorporate two or more standard approach to make tailor made treatment plan. This eclectic approach would help in enhancing verbal communication, quality of life of individual with CAS and their family members, and development of evidence based practices related to intervention of CAS.

FUTURE DIRECTIONS

Heterogeneity among CAS population allows investigation only through case study or case series although case studies are not considered to be generalized across this broader population. But longitudinal studies will inform the eligibility criterion for sub-groupings for controlled trials in the future and facilitate evidence to definitively advocate a particular or combined approach for clinical practice.

Thus, there is a critical need to work towards a consensus on the specific diagnostic features, severity rating scales and outcome measures in this population. Replication of case study across different settings and different individuals would help in increasing external validity and treatment efficacy of combined approaches. Most importantly, careful thoughts should be applied to the design of treatment and incorporation of approaches for this challenging patient group.

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APPENDIX – I

List of trained and untrained stimulus

List of trained stimulus	**List of untrained stimulus**
Word List I 1. /a:m/	1./sʌrotʌ:/
2. /bɔl/	2./pʌhʌ:d/
3. /topi:/	3./kʌhʌ:i:/
4. /ghʌr/	4./adrʌk/
5. /ʧ͡ʰtʌ:/	5./gʌ:dzʌr/
Word List II	6. /su:bʌh/
1. /gi:lʌ:s/	7. /kʌᵑghi:/
2. /nʌmʌk/	8. /tju:tion/
3. /gʌrʌm/	9. /gʰʌdi:/
4. /ki:tʌ:b/	10. /bʌtʌn/
5. /pʌᵑkʰʌ:/	11. /bʌ:dʌl/
Word List III	12. /gʌmlʌ:/
1./bʌ:dʌl/	13. /gᵤ:lʌ:b/
2./gʌmlʌ:/	14. /pʌpi:tʌ:/
3./gᵤ:lʌ:b/	15./mɔbʌ:i:l/
4./pʌpi:tʌ:/	
5./mɔbʌ:i:l/	