Assessment and Treatment of
Children with Apraxia of Speech (CAS)

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Introduction

Developmental motor speech disorders are described in the literature as neurophysiologic-based disorders that manifest in planning, programming and/or the execution problems during speech. These particular disorders typically have an onset during early childhood as the result of a congenital problem or may be acquired later in development as the result of illness or injury. A deficit in planning of skilled movement or speech motor control is generally conceptualized as childhood apraxia of speech (CAS) (Murray, McCabe, Heard, & Ballard, 2015; Nijland, Maasen, & van der Meulen, 2003), while an execution problem with skilled movement results in dysarthria. Murray et al. (2015) summarized the literature and suggested that most researchers feel that the core problem of CAS is one of limited ability to translate or program abstract phonological codes to motor speech commands.

Our interest in this paper is that of CAS, a disorder that is frequently discussed in the literature but is very elusive in terms of identifying definitive diagnostic markers. Many researchers in the area of phonological disorders view the development of speech production as consisting of four neural events (Shriberg et al., 2012; Shriberg et al., 2010). First, there is auditory-perceptual encoding, which acts to transform auditory input into phonemic, sublexical, and lexical representations. The representations are then stored in different memory processes for recall and/or modification. When the speaker is ready to communicate, transcoding processes are employed to plan and program the motor gestures used to produce speech and other forms of expressive output. Finally, the planned motor gestures are realized as muscle specific commands, which result in articulate speech. Please see Figure 1 below.

<table>
<thead>
<tr>
<th>Auditory-Perceptual Encoding</th>
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<td>Transforms auditory input into phonemic, sublexical and lexical representations.</td>
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<th>Memory Processes</th>
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<td>The neural mechanisms for storage and retrieval of the different representations.</td>
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<th>Transcoding Processes</th>
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<tr>
<td>Neural processes involved in the planning and programming of motoric gestures to produce speech and other forms of communication such as signing, etc.</td>
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<th>Neuromotor Implementation Processes</th>
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<td>Muscle specific commands and movement execution.</td>
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In the conceptualization summarized in Figure 1, there is general agreement in the research literature that partial or poorly constructed representations due to encoding and/or memory limitations are causal agents in explaining language impairment and speech delay. Conversely, transcoding problems are thought to be responsible for the deficits identified in the speech of children diagnosed with CAS. That is, there are problems in the planning and programming of the motor gestures used to produce speech. Disorders of neuromotor implementation would result in a dysarthria with potential involvement of respiration, phonation, resonation, and/or articulation.

There are a number of different theories that have been proposed to explain the above theoretical speech production process, and one that will be briefly summarized herein was proposed by van der Merwe (1997; 2008). She hypothesized that messages expressed by speakers are converted from thought to production through a series of hierarchical processes. First, the speaker wants to communicate some idea, thought or desire via verbal communication. The intended message is transformed from an abstract thought to the actual linguistic message. At this transformational level, structural planning (syntactic, morphologic, and phonological units) occurs and is designated as a pre-motor phase in formulation of the message. That is, the thought is transformed into the linguistic message. Next, the message is changed into a code that can be processed into motor movement commands, so that it can be expressed verbally. The conversion includes three distinct phases that in order are: speech motor planning, motor programming, and execution.

Speech motor planning entails the specification of motor goals. Each speech sound has a motor plan that codes spatial (place and manner of articulation) and temporal production parameters; the plans are structure specific (lips, tongue, etc.). For example, production of /p/ includes lip closure and release, velopharyngeal closure, and abduction of the vocal folds. The movements are modified as a function of different phonetic environments. The speech motor plans (Structure specific) are then converted to speech motor programs (Muscle specific). Muscle movement parameters such as tone, velocity, force and range are set so that execution or expression of the message occurs. Planning and programming are steps that occur prior to execution. Execution is the transformation of plans and programs into the actual movements of the sound combinations. According to the theory proposed by van der Merwe, a disorder of motor planning may result in apraxia, while problems in programming and/or execution may result in dysarthria.

Keep in mind that children with CAS typically have not developed speech and then incurred some illness or injury that resulted in a motor speech disorder as in the adult population. Rather, we think that it is a problem of speech motor disorder at some neural level that impacts the development and acquisition of speech. Clinically, a young child with a severe speech sound disorder and limited intelligibility is often given a provisional diagnosis of CAS. The point is that the SLP may be correct in their provisional diagnosis, but CAS occurs infrequently and there
must be sufficient speech production skills to engage in differential diagnosis (Strand et al., 2013).

The Ad Hoc Committee on Apraxia of Speech in Children (ASHA, 2007) conducted an extensive review of the literature and formulated a draft definition of CAS that includes a proposed cause, core deficits and effects of the disorder on communication and literacy development. The definition is as follows:

The Committee recommends the following definition of CAS:

Childhood apraxia of speech (CAS) is a neurological childhood (pediatric) 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 spatiotemporal parameters of movement sequences results in errors in speech sound production and prosody.

Review of the research literature indicates that, at present, there is no validated list of diagnostic features of CAS that differentiates this symptom complex from other types of childhood speech sound disorders, including those primarily due to phonological-level delay (speech delay) or neuromuscular disorder (dysarthria). Three segmental and suprasegmental features that are consistent with a deficit in the planning of movements for speech have gained some consensus among investigators in apraxia of speech in children: (a) inconsistent errors on consonants and vowels in repeated productions of syllables and/or words, (b) lengthened and disrupted coarticulatory transitions between sounds and syllables, and (c) inappropriate prosody, especially in the realization of lexical or phrasal stress. Importantly, these three features are not proposed to be the necessary and sufficient signs of CAS. These and other reported signs change in their relative frequencies of occurrence with task complexity, severity of involvement, and age. The complex of behavioral features reportedly associated with CAS places a child at increased risk for early and persistent problems in speech, expressive language, and the phonological foundations for literacy, and the possible need for augmentative and alternative communication and assistive technology.

Shriberg, Aram & Kwiatkowski (1997) estimate the prevalence of CAS at approximately one to two clients per thousand; however, it would appear that the diagnosis of CAS is assigned to clients on a more frequent basis (Davis & Velleman, 2000). This discrepancy may be in large part due to the variability in diagnostic criteria for CAS and third party reimbursement issues. Suffice to say that CAS is an elusive diagnostic entity (Forrest, 2003), but there are clients who show such disorders and they require treatment. Davis (2002) indicated that limited consonant inventories, use of simple syllable shapes, prosodic differences, vowel
errors (neutralization, diphthongization), and production variability are markers of the disorder. Strand (2003) essentially listed the same factors in her discussion of early CAS markers. She further stated that she is referred many children who are not using speech or may have a limited sound inventory. According to Strand, diagnosis of CAS is not possible if the child cannot imitate speech test stimuli, but limited sound inventories, vowel distortions, and/or excessive use of the neutral vowel are potential danger signals. In her reports to caregivers and practitioners, she writes the following: “The child in not yet able to volitionally attempt imitative utterances that vary in length and phonetic complexity, therefore the diagnosis of childhood apraxia of speech cannot be determined or ruled out at this time.” In sum, remember the features of CAS are elusive and that the child must be able to at least imitate words and phrases of varying length to provide a provisional diagnosis of CAS.

In recent years there have been a number of studies, which have identified groups of children with features that are consistent with a diagnosis of CAS and summaries of the different studies are presented to update the reader. Please refer to Table 1. The most recent study was carried out by Murray et al. (2015). The researchers recruited children suspect of having CAS who were referred by their SLPs. A total of 47 subjects underwent diagnostic testing by two examiners experienced in the diagnosis of CAS and 28 met the criteria for CAS. Following diagnosis, 24 different test measures were then evaluated by raters blind to the original diagnosis. Statistical analysis indicated that syllable segregation, lexical stress matches, percent phonemes correct from a polysyllabic picture-naming task and articulatory accuracy on the repetition of /puhtuhkuh/ achieved a 91% diagnostic accuracy when compared with expert diagnosis. The authors concluded that polysyllabic production accuracy and an oral motor examination including diadochokinesis may be sufficient to identify CAS. Strand et al. (2013) reported on the development of the Dynamic Evaluation of Motor Speech Skill (DEMSS), which is a measure for younger children and those with severe speech sound disorders. The test consists of 66 items that include words with basic syllable shapes (CV, VC, CVC), reduplicated syllables, bisyllabic words, multisyllabic words and utterances of increasing length. Items are scored in reference to overall articulatory accuracy, vowel accuracy, prosodic accuracy and consistency. The authors concluded that the test had adequate reliability and validity and is appropriate for identifying children with severe speech impairment due to complete or partial problems in motor planning and programming speech movements.

The third study was carried out by Shriberg et al. (2012) and examined the use of the The Syllable Repetition Test (SRT). The SRT is an 18-item task generally administered and scored in approximately 5 minutes. The instrument provides a means to assess the integrity of processes underlying nonword repetition in a simple context that minimizes scoring and interpretive problems when respondents have mild to severe articulation errors. Stimuli require respondents to have productive mastery of 5 of the approximately 42 speech sounds: two early acquired nasals /m, n/, stops /b/, d/ along with the back vowel /a/ are used. SRT
competence scores are computed for the four consonant sounds as they occur in 50 target syllables, producing sub-scale competence percentage scores for 2-syllable, 3-syllable, and 4-syllable nonwords and a total SRT percentage correct score known as the SRT Total. In their comparison of four different groups with speech sound disorders, subjects diagnosed with CAS had significantly lower SRT competence, encoding, memory, and transcoding scores than the other subject groups. Subjects in the CAS group were 8.3 times more likely than controls to earn SRT transcoding scores below 80%. The authors concluded that subjects with CAS have speech processing deficits in encoding, memory, and transcoding. The authors concluded that the SRT has moderate diagnostic accuracy to identify transcoding deficits, conceptualized as the primary feature of CAS.

The final study was carried out by Shriberg, Potter and Strand (2011) and examined children who were born with a metabolic disorder known as galactosemia. The assessment procedure examined 10 different areas of speech production, which included vowel production, consonant production, vowel and consonant combinations, prosodic variables of phrasing, rate, and stress, vocal loudness, pitch, quality, and resonance. To be diagnosed with CAS, a subject had to have evidence of four of the following 10 behaviors in three or more of the assessment tasks: vowel distortions, difficulty achieving initial articulatory configurations or transitionary movement gestures, equal stress or lexical stress errors, distorted substitutions, syllable segregation, groping, intrusive schwa, voicing errors, slow rate, slow diadochokinetic rates, and increased difficulty with multisyllabic words. The findings indicated that there was an increased risk of CAS in children with galactosemia despite early dietary management. Please refer to Figure 2 for the areas of evaluative study that were used by Strand to differentiate between CAS and dysarthria.

<table>
<thead>
<tr>
<th>Linguistic and motor domains</th>
<th>MSD-AOS</th>
<th>MSD-DYS</th>
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<tr>
<td><strong>Segmental</strong></td>
<td>1. Vowel distortions</td>
<td>1. Sound distortions</td>
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<tr>
<td>Vowels</td>
<td>2. Voicing errors</td>
<td>2. Reduced strength of articulatory connect</td>
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<td>Consonants</td>
<td>3. Distorted substitutions</td>
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<tr>
<td>Vowels and consonants</td>
<td>4. Difficulty achieving initial articulatory configurations or transitionary movement gestures</td>
<td>5. Scanning speech</td>
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<td></td>
<td></td>
<td>6. Slow rate</td>
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<td></td>
<td>5. Groping</td>
<td>7. Irregular diadochokinetic rates</td>
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<td></td>
<td>6. Intrusive schwa</td>
<td>8. Equal stress</td>
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<td></td>
<td>7. Increased difficulty with multisyllabic words</td>
<td>9. Strained or breathy phonation</td>
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<tr>
<td>Suprasegmental</td>
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<td>10. Reduced range of motion</td>
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<tr>
<td>Prosody</td>
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<tr>
<td>Phrasing</td>
<td>8. Syllable segregation</td>
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<tr>
<td>Rate</td>
<td>9. Slow rate</td>
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<tr>
<td>Stress</td>
<td>10. Slow diadochokinetic rates</td>
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<td></td>
<td>11. Equal stress or lexical stress errors</td>
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<tr>
<td>Voice</td>
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<tr>
<td>Loudness</td>
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<tr>
<td>Pitch</td>
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<tr>
<td>Laryngeal quality</td>
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<td>Resonance</td>
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<tr>
<td>Motor</td>
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Note: MSD-AOS requires vowel distortions and at least three of the listed characteristics in at least three of the MSAP tasks. MSD-DYS requires at least 3 of the 10 listed characteristics in at least 3 MSAP tasks.
In sum, recent studies have developed new measures and test protocols to identify children who appear to have speech sound problems that are related to verbal planning problems. While diagnosis is still a problem, research findings continue to provide data that helps us to advance our knowledge in this area. The more recent research appears to confirm previous findings in that articulatory and prosodic variables are surface features of CAS and assessment protocols need to include such measures to identify children with verbal planning problems. It appears that many of the implemented measures suggest degree of involvement rather than specific isolated measures that are used in the differential diagnosis of CAS from other disorders.

<table>
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<tr>
<th>Study</th>
<th>Study Population</th>
<th>Findings</th>
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<tr>
<td>Murray et al. (2015)</td>
<td>A total of 47 subjects were selected for study purposes. Subjects underwent diagnostic testing and were also subject to review by SLPs experienced in the diagnosis of CAS.</td>
<td>A total of 28 subjects met the criteria for diagnosis of CAS. Test results were subject to statistical analysis. Discriminant analysis of the test variables identified syllable segregation, lexical stress matches, percent phonemes correct from a polysyllabic picture naming test and articulation accuracy of /puhtuhkuh/ as markers of CAS when compared with expert diagnosis.</td>
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<td>Strand et al. (2013)</td>
<td>The authors studied 81 young children with severe speech involvement. They were administered the Dynamic Evaluation of Motor Speech Skill (DEMSS), and a standard speech and language battery. The DEMSS is a newly constructed measure that consists of 66 items that include earlier developing vowels consonants and syllable shapes. It is designed for younger children and those with severe impairment.</td>
<td>The DEMSS is in the process of development and current findings indicate satisfactory reliability and validity. The test was not found to over-diagnose but did not identify all children with CAS.</td>
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<tr>
<td>Shriberg et al. (2012)</td>
<td>The study included 369 subjects who were administered the Syllable Repetition Test (SRT). This is a nonword repetition test for speakers with speech sound errors. Of the 369 subjects, 40 had a diagnosis of CAS</td>
<td>The results indicated that the CAS subjects had significantly lower SRT competence, encoding, transcoding and memory scores. CAS subjects were 8.3 times more likely to have transcoding scores below 80%.</td>
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<td>Shriberg, Potter, &amp; Strand (2011)</td>
<td>Children with galactosemia were identified for study. They present with a metabolic disorder and</td>
<td>The 8 subjects showed at least 4 of the 10 behaviors of the speech sampling tasks</td>
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frequently have a severe speech sound disorder. Eight of the 33 subjects were identified as presenting with CAS.

| including: vowel distortions, difficulty achieving initial articulatory configurations or transitionary movement gestures, equal stress or lexical stress errors, distorted substitutions, syllable segregation, groping, intrusive schwa, voicing errors, slow rate, slow diadochokinetic rates, and increased difficulty with multisyllabic words. |

Table 1. Summary of recent studies.

**Assessment**

The purpose of a communication assessment is to identify the characteristics of the disorder, so that an appropriate diagnosis may be made. The systematic process of elimination is known as differential diagnosis and is a function of the practitioner’s knowledge base, clinical skills and available evidence. In some cases, the diagnosis is very simple, but in others, it can be very difficult as is sometimes the case with children who present with CAS (Moriarty, Gillon, & Moran, 2005; Strand & McCauley, 2008). If we collect the appropriate information during assessment, we can extract information that will be useful in differential diagnosis. The diagnostic process first starts with the collection of history information. Typically, there is preliminary information regarding the client’s communication development, overall development, medical history and the impact of the communication disorder on the child’s caregivers. It is often tempting to make an initial diagnosis as most of us have, but all of the pertinent information has not been obtained. Moreover, our diagnostic suspicions are sometimes negated or modified after we have evaluated the child. The history information is generally reviewed during the assessment along with additional information obtained via interview.

It is clear that there is extreme overlap among diagnostic categories, which compounds the assessment process for the practitioner. For example, a positive medical history may or may not be associated with a speech sound disorder attributed to a phonological or rule-based disorder, but it is often present in the histories of clients with sensory, structural, and motor speech involvement. Factors such as low muscle tone, early feeding problems, gastroesophageal reflux, sleep apnea and significantly delayed speech and language development are some of the problems that might be part of a client’s history. All pertinent data need to be considered when trying to formulate a differential diagnosis.
CAS Phonetic/Phonemic Markers

The following are markers that may be identified in the sound system evaluation. Those in bold have been associated with CAS and the listing includes:
1. There is a very limited consonant and vowel inventory with a preference for a few sounds. For example, the child may use /d/ in substitution for many sounds.
2. Substitution and omission errors are present with significant omission errors present.
3. **Vowel errors are a feature with use of the neutral vowel and/or dipthongization.**
4. The child is using mainly simple syllable shapes (V, CV, VC, CVC).
5. **Variability in sound production is present.** The child may imitate stimuli and there is a great deal of variability in repeated productions. A measure of variability is difficult when children have limited expressive vocabularies. The use of intrusive schwa may be noted.
6. Groping behavior is sometimes noted. It looks as if the child is trying to rehearse or “practice silently” the movements necessary to produce a sound or sound combination.
7. **Suprasegmental variation refers to prosody,** which is the flow of speech and we superimpose those features on speech segments. When speaking, we vary pitch, loudness, and time (pause, lengthening) to give speech its rhythm or melody. Prosodic errors such as slow speaking rate, equal and excess stress, silent pauses at the beginning of words or between syllables (syllable segregation), limited variation in F0, reduced loudness, and problems signaling lexical (word stress) and emphatic stress (e.g. stressing a word or phrase in an utterance to signal some type of meaning) are features of CAS.

A Recommended Diagnostic Protocol

1. Obtain Relevant Case History Information.

Purpose: identify any coexisting variables or case history correlates.

The diagnosis of CAS must be made very carefully and all defining characteristics considered. Examine the case history data for any of the features that have been discussed. They are potential markers, and they need to be identified if present.

Case History. Questions for the child’s caregivers, which need to be modified according to age (Hodge & Hancock, 1994).

1. General concerns of caregiver or behavior observed during assessment.
   A. What is the history of the communication problem?
   B. Do others in the family have a similar problem?
   C. Is there a history of feeding problems?
   D. Is the child a mouth breather?
E. Does the child drool?
F. Does the child have a history of hearing problems?
G. Does the child have any visual problems?
H. Does the child appear to have any problems with muscle coordination?

2. Communication interactions of the child in the natural environment.
   A. Does the child use gestures, facial expression, and/or body movement to communicate?
   B. Does the child use sounds in her/his communicative interactions?
   C. Does the child use crying, vocalization, sounds or simple syllable types when trying to communicate?
   D. Does the child use single words to communicate wants and/or needs?
   E. Does the child combine words together to produce meaningful sentences?

3. Communication partners who interact with the child.
   A. Does the child attempt to communicate with familiar adults?
   B. Does the child attempt to communicate with unfamiliar adults?
   C. Does the child attempt to communicate with peers?
   D. Does the child attempt to communicate with unfamiliar peers?

4. Intelligibility of the child in various communicative situations?
   A. Is generally understood by those who talk with her/him.
   B. Is sometimes understood by those who talk with her/him.
   C. Is occasionally understood by those who talk with her/him.
   D. Is never understood by those who talk with her/him.

5. Reactions of the child to communication interactions.
   A. Is the child aware of her/his speech problem?
   B. If so, what is the reaction of the child to unsuccessful communication attempts?
      Refrains from talking, Repeats the message, Uses supplementary techniques such as nonverbal cueing or other repair strategies.

   A. What is the current grade level of the child?
   B. Has she/her experienced any academic difficulties?
   C. What are the child’s grades in the academic content subjects such as Reading, Spelling, Mathematics, and Writing?

Potential Coexisting Variables

CAS History Markers (Davis & Velleman, 2000).

The following are markers that may be part of the history information:
1. A family history of communication disorders.
2. Children with CAS may show co-morbidity with autism, epilepsy, Fragile X Syndrome, Galactosemia, and Rett Syndrome.
3. There is no reported or observed structural disorder that can explain the problem such as malocclusion or some other structural variable.
4. There is no muscle weakness, paresis or paralysis. Parameters of strength, speech, range of motion, coordination and the ability to vary muscular tension appear unaffected.
5. No reported sensory problems with hearing, tactile or kinesthetic modalities.
6. Reported to understand more than what she/he seems to express.
7. More likely to be male than female.
8. The intellectual range follows the normal IQ distribution; however, some may be in the slow-learner range.
9. Cognitive Observations: Will engage in symbolic play but may have problems sequencing play activities. For example, the child carries out two activities (Plays with baby and food appropriately as separate activities but does not integrate them into a play scheme such as dressing the baby, then feeding the baby, then having the baby sleep). Other types of sequential play activities may be delayed: such as stacking different size cups/rings, etc.
10. Lack of flexibility: same task can only be done one way. Difference between automatic/functional vs. elicited gestures (e.g., lick a sucker vs. pretending to lick a sucker)
11. Eating problems, drooling (sloppy eater)
12. Academic learning problems such as reading problems in the family are reported.
13. Parents often report problems with attention (focus), vestibular function, temperament, fine hand use, maintaining attention, and learning to write.

**Early Prelinguistic Critical Markers**

- Prelinguistic perlocutionary, illocutionary and feeding behaviors
  - Lack of CV babble pattern:
    - Marginal babble output but consonant production not present consistently
    - Vowel repetitions rather than consonant vowel (CV) combinations.
    - Restricted CV babble, with limited variety of either consonants or vowels or both (e.g., no variegated babbling pattern noted)
  - Uncoordinated feeding patterns, sloppy eater

**Early Speech Locutionary Behaviors**

- Individual sounds used to signal word meaning: C alone or V alone
- Limited variety of syllables (CV homonymy in place of many words)
- Specific word shapes with apparently consistent meaning (e.g., [a?i] = baby doll; [ma:ma:] = happy.)
- Idiosyncratic home sign development
- Lack of variation in intonation pattern
- Cannot combine different syllables, use of reduplication exclusively or has specific or preferred point of articulation (e.g., labial - alveolar)
- Oral motor incoordination, particularly for non-automatic sequences
- Groping
Words seem to be learned, then disappear (higher rate than normally expected at a young age).

Basic SVO word order may be in error, if using those linguistic structures.

2. Conduct a Speech Assessment

The speech evaluation must include assessment procedures that will allow the examiner to identify potential features of the speech disorder. There are a formal tests and published measures that have been developed for the assessment of CAS. The tests include *The Screening Test for Developmental Apraxia of Speech* (Ages 4-12 years) (Blakely, 2000), *the Verbal Motor Production Assessment for Children* (Ages 3-12 years) (Hayden & Square, 1999), *the Kaufman Speech Praxis Test for Children* (Ages 2-6 years) (Kaufman, 1995), *the Verbal Apraxia Profile* (Ages 3-13 years) (Hickman, 1997) and the *Verbal Dyspraxia Profile* (Birth- 2 years) (Jelm, 2001). There are pros and cons to each of the test batteries, so you will need to investigate each prior to purchasing a commercial product. You can also construct a phonetic/phonemic battery that will allow you to identify potential characteristics of the disorder.

A battery for the identification of CAS should include:

1. **Sound System Assessment.** In constructing a test battery if you choose to do so, you need to use a comprehensive articulation test such as the *Fisher-Logemann Test of Articulation Competence* (Fisher & Logemann, 1971), *Templin Darley Tests of Articulation* (Templin & Darley, 1969) or the *Goldman-Fristoe Test of Articulation* (Goldman & Fristoe, 2000) and a spontaneous speech sample of approximately 3-5 minutes of conversation. With children who have expressive vocabularies of 50 words or less, you can present a limited number of picture items for them to produce. Refer to Appendices A and B for analysis information.

   **Purpose:** identify the client’s phonetic and phonemic inventories and syllabic structure.

2. **Prosody.** The child’s productions of pictures (individual words) and spontaneous speech need to be analyzed for prosodic variation. That is, do the word and conversational utterances show appropriate word stress, intonation contours, pause and inflection? In the case of clients with limited production capabilities, it is difficult to assess prosodic variables such as word stress, intonation contours, inflection, etc. Kent (1988) recommends that the child be asked to hum or engage in reiterant speech. For example, the child could be asked to hum a certain stress pattern of a presented utterance such as Happy Birthday, or use a reiterant speech syllable such as /ma/ or /ba/ in reproducing an utterance. Kent’s example of “Twinkle, twinkle, little star” would be reproduced as BAb a BAb a BAb a BA.

   **Purpose:** evaluate the client’s prosodic structure.

3. **An oral motor examination.** An examination of the structure and function of the
speech mechanism is undertaken. A systematic inventory such as contained in Appendix C. may be employed or one of a number of standardized measures may be used. With very young children, you may only be able to assess oral structures but not function of those structures due to the child’s age. You can, however, observe movement of the oral structures during your assessment interactions with the child.

**Purpose: to evaluate the structure and function of the speech mechanism.**

4. **Examine speech motor control.** Speech motor control is screened through the use of repetitive speech stimuli (diadochokinesis). Remember that reliable repetitions are typically obtained with children 5 years of age and older. It can be used with younger children but the clinician must be very cautious with the results. For older children (5+), diadochokinetic rates for single and multi-syllabic syllables are elicited. The child needs to produce the test items in accordance with standardized test data as provided in Appendix C or in relation to a clinician-devised procedure.

   Stimuli: puh, tuh, kuh, puhtuh, puhtuhkuh

The clinician is looking for accurate, rapid, sequential productions that are coordinated with appropriate stress across units. Imitate productions for the client prior to a particular stimulus trail. If necessary, use a grapheme to cue the client. The client should be asked for 3 to 5 trails for each stimulus and each trial should be timed to allow at least a 5 second trial. If a child misarticulates a certain consonant stimulus, eliminate it. Generally, the average child produces between 3 and 6 repetitions per second for /puh/; 3 to 5 1/2 repetitions per second for /tuh/; and 3 to 5 per second for /kuh/ and repetition rates of 1 to 1 & 1/2 repetitions per second for /puhtuhkuh/.

**Purpose: screen speech motor control.**

5. **Examine speech processing skills.** Satisfactory performance on the nonword Syllable Repetition Test (SRT) requires the processing operations that were discussed previously and are presumed to be neural skills involved in language learning, including transforming the acoustic-phonetic sequence into its constituent phonemes, maintaining the ordered and phonologically coded string in working memory, and organizing the articulatory output. The SRT is an 18-item task that consists of nonsense words in 2, 3, and 4 syllable combinations that the client is instructed to imitate. It includes only the early developing consonants /b, d, m, n/ paired with the vowel /a/. Specific problems in test performance suggest speech-processing constraints that may be identified through different error analyses. A technical report with performance data and a PowerPoint presentation of the Syllable Repetition Task (SRT) can be downloaded without cost from the Technical Reports section of the Phonology Project Web site at http://www.waisman.wisc.edu/phonology.

**Purpose: assess the speech processing skills of the client.**

6. **Morphophonemic Alterations.** Examine the client’s production of words, which
increase in length as produced through imitation. These data help determine if articulation breakdowns occur as a function of word length and grammatical complexity. In addition, the clinician can find out if any silent posturing or groping of test stimuli occur, and examine word stress of single and multisyllabic words. A self-generated list of words can be used to examine productions across 1 to 3 syllable words. For example, items such as pain, painful, painfully can be used. At least 8 to 10 different stimuli need to be included. This task cannot be used with very young children who have limited expressive vocabularies. See Appendix D.

**Purpose:** determine if production differences exist as a function of word length and morphological complexity.

7. **Imitative Consistency of Word Productions as a function of Multi-Syllabic Structure and syntactic complexity.** Assess the consistency of multi-syllabic production of words as produced imitatively by the client. The client is asked to produce 2, and 3 syllable words across three separate trials. For example, the child is asked to say the word “popcorn” three times with a short pause between each production. The clinician produces the word and child is asked to say it with a brief pause between each production. A word list containing multisyllabic words should be used. For instance, words such as baseball, basketball, may be used. With very young children, you can use a list of words with simple syllable shapes across 3 production trials. Another component involves the manipulation of grammatical length. For example, the clinician could present in order for the child to imitate: Dog, A dog, A big dog, A big dog runs, A big dog runs fast. See Appendix D for stimuli.

**Purpose:** determine consistency of speech sound production, determine if any silent posturing or groping of test stimuli occurs, examine word stress patterns and linguistic complexity production changes.

8. **Evaluate Nonspeech Oralmotor Movements and Oral Feeding Skills**

1. **Oral Movement Assessment.** If necessary, a test of isolated and sequenced nonspeech volitional movements may be carried out. This is done to determine if isolated or sequential nonspeech oral volitional movements are also problematic for the child. Tasks such as “smile,” “Open your mouth,” and “Bite your lower lip and then smile” can be used to study nonspeech oral volitional movements. The clinician can also assess activities such as chewing gum, sucking a lollipop, straw drinking or sequenced activities such as using a straw to access the liquid in a juice box in automatic and pretend contexts to see if there are differences. For example, a child may be able to lick a lollipop, but the child cannot pretend to lick a lollipop when prompted to do so. Refer to Appendix E.

**Purpose:** determine if there are problems with nonspeech isolated or sequential oral motor volitional movements.

9. **Oral Phase Feeding Skills.** If necessary, a short screening of oral phase feeding skills
can be undertaken to observe oral preparation and motility. A small amount of water in a cup, a small portion of food such as applesauce, and a chewable food such as a cookie or cracker should be given to observe the child eating.

**Purpose:** observe the client’s execution of nonspeech movements and oral motility for feeding.

10. Assess the Language Skills of the Child

1. Collect observations of the language and language processing skills of the child via standardized tests and measures. Many children with severe speech sound disorders across the etiological categories will also present with higher-level language deficits, and they will need to be identified so that treatment may be introduced. In addition, there are subgroups of children who will need further testing. For example, children with a cognitive basis for their language deficit such as intellectual delay need to be identified, since cognitive impairment can be a causal factor

**Purpose:** assess the language skills of the child to establish a level of function and identify any intervening variables.

11. Differential Diagnosis

Use the data to provide a differential diagnosis (See Summary Checklist). Is the practitioner able to identify the features of CAS as differentiated from the other diagnostic speech sound categories? Are there coexisting factors such as history information that are consistent with CAS or one of the other etiological categories? Please note that some practitioners like Hayden (1994) speculate that CAS and developmental dysarthria are often confused in diagnosis. Consequently, one should very carefully examine the diagnostic features that have been identified to identify a pattern that is consistent with a planning disorder (CAS). If not, the other categories of speech sound disorder need to be considered in determining a diagnosis and planning treatment.

**Summary Checklist**

1. Consonants
   A. Phonetic Inventory:
   B. Phonemic Inventory:
   C. Error Types: ___ Substitutions ___ Distortions ___ Omissions

2. Vowels
   A. Vowel Errors:
   B. Error Types: ___ Distortions ___ Substitutions ___ Limited Vowel Space

3. Contextual Errors ___ Problems with achieving initial articulatory contacts or difficulty with transitions from sound to sound.
There is a very limited amount of empirical research, which has examined treatment efficacy for clients with suspected CAS (Bahr, Velleman, & Ziegler, 1999; Gildersleeve-Neumann, 2007; McCauley, 2003; Murray, McCabe & Ballard, 2014; Murray, McCabe & Ballard, in press; Strand & Debertine, 2000). Our current treatment concepts are based largely on single subject case study reports and the expert opinion of professionals who deal with such clients. A most recent review by Murray et al. (2014) indicated that there are some treatments with data to support their efficacy; however, the level of evidence is limited at this time. In their extensive review, there were empirical data to support Integral Stimulation (Edeal & Gildersleeve-Neumann, 2011; Strand & Debertine, 2000), Rapid Syllable Transition Treatment (ReST) (Ballard, Robin, McCabe, & McDonald, 2010), and Intergrated Phonological Awareness Intervention (Moriarity & Gillon, 2006). A most recent RCT study and the only one to date reported by Murray, McCabe & Ballard (in press) found positive results for ReST and the Nuffield Dyspraxia Programme (3rd ed. :NDP3) when conducted intensively; however, ReST had greater external evidence. Although different theoretical rationales have been proposed to explain CAS and thus treat it, there remains limited empirical evidence, which is slowly changing. Table 2 presents a general summary of four treatments that have evidence to support their efficacy. However, prior to discussing these treatments, treatment recommendations for very young children suspect of having CAS will be discussed.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Theoretical Orientation</th>
<th>Major Treatment Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Integral Stimulation/Dynamic Temporal and Tactile Cueing</td>
<td>Motor Learning Based</td>
<td>Emphasizes use of repetition and imitation with extensive use of auditory and visual models. Dynamic Temporal and Tactile Cueing is a variation that includes specific...</td>
</tr>
</tbody>
</table>
production steps for children with severe CAS. Treatments begins with vowels with each target practiced under different cueing conditions.

<table>
<thead>
<tr>
<th>2. Rapid Syllable Transition Treatment (ReST)</th>
<th>Motor Learning Based</th>
<th>This treatment incorporates sound and prosodic practice to develop sound production skills and appropriate prosody, particularly at the lexical level. Multisyllabic nonwords are used as practice items.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Nuffield Dyspraxia Programme (3rd ed. :NDP3)</td>
<td>Motor Learning Based</td>
<td>The treatment addresses motor planning and programming through the use of practice items that encompass isolated sound productions, different syllable shapes and transfer to sentences and connected speech.</td>
</tr>
<tr>
<td>4. Integrated Phonological Awareness Intervention</td>
<td>Linguistic Based</td>
<td>The authors use a linguistic approach that includes speech production skills, phonological awareness, and printed word decoding skills. Targets are selected on the basis of a phonological process analysis.</td>
</tr>
</tbody>
</table>

Table 2. Treatments that have produced empirical treatment data to support their use.

Clinicians must be mindful of the fact that there are some critical issues that must be considered when dealing with very young children presenting with severe impairment. First, some children are essentially nonverbal or have extremely limited expressive vocabularies. Second, some of these children cannot imitate speech stimuli. These issues create a clinical conundrum, since the critical criteria for diagnosis are **(a) inconsistent errors on consonants and vowels in repeated productions of syllables and/or words, (b) lengthened and disrupted coarticulatory transitions between sounds and syllables, and (c)**
inappropriate prosody, especially in the realization of lexical or phrasal stress. SLPs may feel very strongly that a child has CAS, but the child, particularly the very young child, must have some verbal skills to enable appropriate testing. If SLPs are unable to test verbal skills, but have a strong suspicion of CAS, they should provide a provisional diagnosis and then conduct diagnostic therapy with the child. This will enable the child to acquire some communication skills and potentially be assessed to determine if CAS is a valid diagnosis. Diagnostic therapy should not emphasize speech development but rather communication development. That is, some clients may not be able to acquire productive speech that is intelligible; consequently, the clinician must factor this into account when developing a reasonable expectation for client diagnosis and potential long-term improvement.

The treatment recommendations (what to teach and how to teach) that follow are presented on a continuum that reflects the residual verbal skills of the client. They range from nonverbal/limited verbal skills children without imitative speech skills to children with varying levels of verbal skills. The common factor is that they are suspected to present with a verbal planning problem and are given a provisional diagnosis or a diagnosis of CAS. Keep in mind that the major guiding principle of treatment is meeting the communication needs of the client through continuous immersion in a variety of communicative interactions.

**Treatment Recommendations for Very Young Children-Provisional Diagnosis**

1. Treatment needs to be carried out on a frequent basis. Intensive treatment for periods of 3 to 5 times per week allow for distributed practice that emphasizes motor planning and production and/or the co-development of phonological awareness/literacy skills. If this is not feasible and many times it is not due to the service limitations available, home practice with the child’s caregivers is paramount. This component of treatment can only be implemented, if the parents are willing. Caregivers willing to participate need training prior to the introduction of home practice using different naturalistic communication treatment strategies. Moreover, some type of contract between the SLP and parent should be negotiated, so that respective roles are clearly delineated. Please see Appendix F for different language-based strategies that may be used with young children.

With these language elicitation strategies, the child takes the lead in play and the parent follows in the most natural of the approaches. The rationale is to provide a correspondence between the child’s actions and the language that describes those actions. The teaching techniques are to be used in combination throughout the day. Whenever an opportunity occurs the parent can use the techniques. These are particularly useful for a child with a limited lexicon who has potential to expand his/her language, which is what we want. Often times, these children do not talk or talk very minimally in the clinical setting.

In addition to using the elicitation techniques, the parent should be taught to modify the actual linguistic input to the child. For instance, the clinician can modify
the rate of speaking to the child. Reducing rate is a way of modifying input that may
be beneficial to the child. Second, children may benefit by varied repetition of
language experiences. Some researchers feel that children with language
impairment need varied repetition to learn language. Third, have parents enhance
perceptual saliency through prosodic variation. Emphasis or stress on specific
words may make them salient to the child. Fourth, language input to the child
should be slightly longer than the child’s level of language production. For instance,
if a child is using one word utterances, we would want parents to use 2-3 word
utterances and address semantic concepts that are familiar to the child. That is,
parents need to talk about things that the family is familiar with in their language
interactions. New semantic concepts can be introduced but they should be highly
structured for the child.

2. For some clients on the severe end of the speech production continuum, it may be
necessary to implement some form of augmentative/alternative communication
exclusively or in combination with speech as an initial treatment step (DeThorne, et
al., 2009). For example, a core vocabulary book that contains familiar pictures of
people, places, and actions may be a good stimulator. Sign can also be very effective
with some children. See Appendix G for a list of sign resources.

Caregivers play a vital role and should be educated to acknowledge and
reinforce the communicative attempts of the client, whether they be vocalizations or
some form of idiosyncratic gesture in combination with vocalization. Vocalizations
should be encouraged and can be carried out in the context of body movement or
activity. For instance, a child may pair vocalization with play. The clinician and
client might play with a favorite toy such as a car and make a “vroom” sound while
playing. Caregivers also need to provide appropriate models of communication for
the client. Idiosyncratic signs or gestures can be modified to more general signs or
gestures, and caregivers can model appropriate word targets of the client’s
vocalizations. See Treatment Recommendation 1 and Appendix F.

When the child begins to produce vocalizations consistently, treatment should
shift to sounds combined in various syllabic structures. Early developing
consonants such as /b, m, w, m, n, and j/ are potential targets. They can be paired
with early developing vowels like /I, e, u, a/. Potential syllabic configurations may
include CV, CVCV, and CVC. Other consonant sound additions should be introduced
in syllabic shapes that the child uses, and new syllable shapes should be introduced
with consonants that are in the client’s inventory. Practice with syllables should be
varied to allow for motor planning

3. DeThorne et al. (2009) examined the literature and identified a number of
evidence-based treatment strategies for clinicians that may be used with very young
children who do not imitate verbal stimuli and have very limited expressive
vocabularies. They are good starting strategies for beginning diagnostic treatment.

3a. Try to structure the treatment sessions in a way that does not cause
anxiety and stress for the child. Make sure that the caregivers do not make
unrealistic demands on the communication skills of the child. Interactive play such
as the use of puppets or other materials is a way to reduce communicative pressure
on the child. Follow the child's lead in an interaction and minimize the use of questions to elicit desired responses.

3b. Imitate the child's actions and vocalizations while interacting in treatment. For example, if the child vocalizes moo, moo, the SLP can imitate the sounds and then talk about the animal that makes the moo sound. The clinician produces the vocalization and then expands to include a linguistic message.

3c. When talking, use variety in intonation contours and use a slower speaking rate. Prosody is the suprasegmental component of speech that is used to signal linguistic and emotional features during speech production. Suprasegmental features include: (1) syllable stress, (2) intonation, and (3) rate/rhythm (Kehoe & Stoel-Gammon, 1997). Naturalness is a perceptual term used to describe the adequacy/inadequacy of prosody for a particular speaker. The clinician should emphasize word stress and phrase-sentence intonation patterns. Employ the systematic use of rhythm, intonation, stress and accompanying motor movements in speech practice. Some clinicians advocate rhymes and songs as agents in practice. Rhythm drills can be executed through simultaneous speech and body motor movement. For instance, the clinician could have a client practice speech production, while maintaining a beat with a drum or some other motor activity.

3d. Enhance sensory information that you are giving the child. Increased stimulation may facilitate speech production. There are many types that can be used with the child. For example, the child and SLP can tap their lips with a finger-tip prior to producing a bilabial sound.

3e. Avoid emphasis on nonspeech preparatory stimulation in favor of speech activities. If alveolar stops are being targeted, it would be better to attempt tuh, tuh rather than doing nonspeech activities such as just clicking the tongue. Make sounds that are meaningful and always pair the practice with words that are meaningful to the child. Expand linguistically upon everything that the child does and do not engage in nonspeech oral motor activities with the purpose of stimulating speech.

4. Phonotactic constraints are the rules of a language that govern permissible word and syllable shapes and can be used in developing treatment stimuli for children with limited expressive skills. For example, Velleman (1994) provides an example of a specific activity that was used. In order to introduce and practice CV syllable shapes, a “baba board” are devised. Pictures are placed on a board and CV shapes used as the initial verbal representations of the stimuli. For example, /ba:/- sheep, /mu:/-cow, /bu:/-ghost, and /ni:/-knee are simple syllable associations that were employed. In presentation, the clinician points to a picture, and the child produces the CV representation in practice trials. The child is also instructed to self-monitor the accuracy of productions.

General Treatment Recommendations- Diagnosis of CAS

Reports on treatment for CAS indicate that therapy is intensive and generally required over a number of years (Campbell, 1999). The following treatment strategies have been proposed by a number of investigators for utilization in
therapy for the child with some speech and language and the skills to imitate (Bernhardt, 1994; Cumley & Swanson, 1999; Davis & Velleman, 2000; Hall, Jordan, & Robin, 1993; Love, 1992; Marquardt & Sussman, 1991; Robin, 1998; Square, 1994; Skeleton & Hagiopian, 2014; Strand & Debertine, 2000; Strand & Skinder, 1999; Velleman, 2003; Velleman, 1998; Velleman, 1994; Velleman & Strand, 1994). As cautioned previously, the treatment recommendations have not been subject to rigorous empirical examination but are based on judicious clinical judgment and a modicum of treatment efficacy research.

1. A motor skill learning approach is recommended by some authors to emphasize practice at different levels of linguistic complexity. Isolation practice should be avoided in favor of contextual practice at syllable, word, phrase, sentence, and conversational levels. The rationale is to provide systematic practice, so that there are numerous opportunities to provide the client with internal feedback and clinician provided knowledge of results. The four basic components of motor learning according to Gildersleeve-Neumann (2007) are client readiness, practice consistent with the child's needs, feedback, and speaking rate during practice.

   1a. Client readiness is analogous to the concepts of capability and focus. These are intangible factors that deal with the internal motivation of the client. As clinicians, we want the child to have a vested interest in the treatment and “believe” that it will work. We need to motivate the child to do her/his best and encourage them to focus on the tasks at hand. Explaining to the child what you are doing with them and having them experience early success helps in their readiness to learn and improve their speech disorders.

   1b. Practice is important, not for the sake of practice, but to provide opportunities for meaningful practice of a target. Practice that is distributed over time is better than one massed session of practice. That is, it is better to practice for short periods of time, possible three times a week rather than one day of massed practice. Another practice condition is that of random versus blocked practice. When working on a target sound in context, the clinician can use a list of practice words with the target sound (p-pie, pot, Pam, pot) (Block practice) or use a list that contains the target words interspersed with non-target words (p-pie sew, pot, sack, bye, Pam, one, pot) (Randomized). A variation might be to start with block practice at a level of therapy and then switch to randomized practice.

   1c. Feedback is very important for the learner and there are two types that you need to be cognizant of in therapy. The first, extrinsic feedback, is knowledge of results (KR) and that is information provided by the clinician. It can be qualitative (Good job!), quantitative (You brought your lips together and then let them go and made the /p/ sound in the word pie) or a combination of the two. Quantitative feedback is reported to be more effective in learning. Intrinsic feedback is that obtained from the client’s sensory input and conscious introspection (knowledge of performance, KP). Auditory self-monitoring is considered an important component of intrinsic feedback and should be emphasized in treatment and outside of treatment. As the child progresses in treatment, feedback should be gradually reduced in treatment sessions with greater emphasis on metaphonological analysis.
and self-monitoring and attempt to develop these skills with the client. Engaging in the analysis of where a sound is made in the oral cavity, and judging the accuracy of one’s productions are important components of treatment. Clinicians need to be mindful of the fact that introspective skills such as these should be used with clients who are approximately 5-6 years of age and older.

1d. The presentation of stimuli should be varied to facilitate learning. Initially, the clinician should reduce the rate of speech when presenting stimuli to the client. Similarly, the client should provide responses with a slow rate. The rationale is to allow for motor planning on the part of the child. As therapy progresses rate increases to normal prosodic expectations should be introduced.

2. One approach that is used and incorporates motor learning principles is that of integral stimulation. Strand and Skinder (1999) have developed an approach to treatment that is based on principles of motor learning and employs practice procedures directed to sensorimotor planning. It was originally developed for acquired apraxia (Rosenbek, et al., 1973) but was adapted by the authors for younger clients. The major features of the approach are that the client responds to various cues and practice response time delays, and the client’s response to the treatment dictates the specific stimulus presentation mode. In order to implement the program, a prospective client must be able to attend for at least 10 minutes at a time, maintain eye contact and be able to imitate the treatment stimuli.

**Goal of Step 1.** The goal of the initial step is production of target items with correct articulation, normal speaking rate, and prosody following direct imitation.

**Step 1.** The clinician presents the practice stimuli in a direct imitative manner with a reduced speaking rate. If the client can imitate the stimulus, direct imitation continues with the clinician varying the speaking rate and prosody of the target items. The clinician provides practice trials and manipulates rate and prosody, while maintaining correct production of target stimuli. Direct imitation continues until the client can produce the targets with correct articulation, normal speaking rate, and prosody. Appropriate KR (extrinsic feedback) is given to the child and intrinsic feedback, particularly auditory-self monitoring is introduced.

If the client cannot correctly imitate the target items, he/she is instructed to produce the targets in concurrent fashion. That is, the client produces the targets simultaneous with the clinician’s model (The child says it with the clinician simultaneously). If the client cannot produce the targets simultaneously with the clinician, a reduced production rate and tactile placement cues are used to achieve correct production. Simultaneous production continues until the client can produce the targets with correct articulation, normal speaking rate, and prosody. At that time, the clinician reintroduces the direct imitation condition.

**Goal of Step 2.** The goal of step 2 is production of target items with correct articulation, normal speaking rate, and prosody following delayed imitation of at least three seconds.

**Step 2.** Time delays between the imitative cuing of the clinician and the
client’s response are now introduced. The clinician explains what is to be done and may develop a signal such as pointing to the client when it is time for the delayed imitative response. Initially, the authors recommend that a two second delay be introduced and gradually increased to 3 seconds. Practice should be continued until the client can produce the target items with correct articulation, normal speaking rate, and prosody following the introduction of the delay.

If the child experiences problems with Step 2, the clinician may shorten the delay period or revert back to direct imitation. After a period of practice, the clinician either increases the delay or reintroduces the delay condition, depending on the branch alternative selected.

Strand and Skinder (1999) indicate that completion criteria for a specific goal should be determined through daily mini-tests of the child’s performance, not the day-to-day accuracy performance percentages that are typically collected for clients with sound system disorders. For example, the clinician is working with the client on establishment of /sp/ clusters in the prevocalic position. A practice group of 6 word items is used. The clinician is using integral stimulation for the introduction of practice stimuli and tracking performance or what is known as response to training.
trials. At the end of each session, the clinician again presents the group of words used. Each item is presented only one time. The presentation of the stimuli will depend on the level of practice. If working at the direct imitative level, use an imitative model, if at the delay plus model level use that type of stimulus presentation. Utilize the mini-test results to determine goal completion. If the child performs at a level of 80% to 90% accuracy for 2-3 consecutive sessions, the clinician can then introduce a new higher-level goal or other stimulus items.

3. The clinician must be cognizant of coexisting communication problems and the need for possible therapeutic intervention. Language, literacy skills and phonological awareness may need to be targeted in during the course of the client’s treatment (Lewis et al., 2004).

4. Employ the systematic use of rhythm, intonation, stress and accompanying motor movements in speech practice (Helfrich-Miller, 1984). Some clinicians advocate rhymes and songs as agents in practice. Rhythm drills can be executed through simultaneous speech and body motor movement. For instance, the clinician could have a client practice, while maintaining a beat with a drum or some other motor activity.

5. **Rapid Syllable Transition Treatment (ReST).** Ballard et al. (2010) developed a treatment for CAS that emphasizes prosody and is known as the Rapid Syllable Transition Treatment (ReST). The researchers demonstrated positive results for their subjects (See Table 2). Subjects produced nonsense multisyllable words in carrier phrases and the emphasis or primary stress syllable was indicated to the subjects by bold type as they were presented orthographically. For instance, He bought a *tubiga*. I want a *bugita* are examples. Children were given knowledge or results and knowledge of performance during the treatment. Initially, KR was given and gradually faded to incorporate KP, so that the children could self-monitor their performance on training trials.

The actual practice stimuli consisted of 3-syllable nonsense words containing plosive speech sounds and three different vowels (CVCVCV). Practice items such as batigu and butiga were used for practice purposes. Different word stress patterns were used and the stimuli were presented to the subjects via standard orthography and stress syllables in bold (*baateego*; *baateeeo*). Treatment sessions consisted of prepractice and practice phases. Prepractice involved the practice of 10 randomly selected practice items that were presented in the context of a carrier phrase ("Can you find my ___?"). The SLP modeled the stimuli for the clients to produce. The client’s productions were then evaluated by the SLP and appropriate performance information provided to shape correct productions. The important production features that were highlighted were emphasis (correct stress pattern), fluency (satisfactory speaking rate without pausing, hesitating, or repeating), and loudness (maintaining overall intensity level for the sentence). After meeting prepractive criteria, practice shifted to the actual practice condition. At least 110-120 practice trials were completed in each practice session. The different syllable strings were
presented orthographically and the clients produced the written stimuli as presented on the cards. Knowledge of results regarding accuracy was provided by the SLP on a variable basis that started at 100% to 50% and then 10% in each session. Modeling was not used but clients were instructed to self-monitor and judge each trial. The treatment was carried out 4 times per week for 3 weeks. Each session was an hour in length.

6. **Nuffield Dyspraxia Programme (3 rd. edition; NDP3)**. It is a comprehensive, commercially available treatment that may be used with clients in the age range of 3 to 7 years (Williams & Stephens, 2010). The treatment utilizes a psycholinguistic framework to treat motor planning and programming problems. Motor learning principles are employed in the delivery of the program. It begins with the introduction of isolated speech sounds and moves from simple to more complex syllable shapes, then to sentence level material and connected speech. Goals are based on segments, syllable shapes, or prosody, applied through a program hierarchy. Target test and intervention items are presented via basic black and white line drawings divided into three components: single sounds (vowels, diphthongs, consonants) words of different phonotactic structure (CV, VC, CVC, CCV, etc.) including polysyllabic words, and phrase, clause, and sentence configurations. The authors indicate that the major goal is improving motor planning but that there is also a strong linguistic component, since newly acquired speech targets become incorporated into the child’s phonological system of sound contrasts and phonotactic skills.

Williams & Stephens (2010) indicate that the treatment program provides exposure to and skill training in:
- Sound discrimination.
- Develop appropriate phonological representations and motor programs for a variety of sounds, syllables, and words.
- Execute newly learned motor programs and incorporate the programs in contrastive contexts.
- Develop imitative control of unfamiliar words and nonwords.
- Discriminate speech sounds according to onsent and rime.
- Acquire appropriate segmentation and sound blending skills.

The components of the treatment begin with single sounds and extend to spontaneous speech. A brief summary is as follows:

1. The initial goal of treatment is to expand the inventory of motor programs for vowels and consonants. The SLP first presents sounds in the child’s phonetic inventory and then introduces sounds that the child does not use or have imitative control. Pictures, diagrams of the articulators and manual cues are used and practice is done in the context of CV syllables. After the sounds have been acquired, they are incorporated into contrastive activities (p versus t, b versus d, etc.).
2. The next step involves an expansion of the child's phonotactic skills. At this stage the client can produce a range of consonants and vowels and the goal is to increase syllabic and word complexity. In addition, contrastive training is also employed so that contrasts such as po/pope, tar/star are part of the treatment paradigm.

3. The final stage of the treatment is transfer to connected speech. The client initially practices word combinations that are elicited via different pictures. As the client improves, more complex material and language formulation tasks are employed. The terminal goal is transfer to connected speech.

7. Integrated Phonological Awareness Intervention. This is the linguistic based approach that was developed by Moriarity & Gillon (2006). The rationale for this treatment approach is that the child's phonological representations are deficient; consequently, treatment should be directed to develop the client's phonological representations via sound production and different higher-level phonological awareness tasks. Development or improvement in those representations is achieved through treatment of speech, phonological awareness, and literacy skills. One phonological process is selected to be targeted in treatment. The selection of a specific target is based on the criteria for target selection that was proposed by Hodson & Paden (1991). The ordering of the patterns depends on the stimulability of the child. That is, the most stimulable targets are chosen first for training, so that the client will experience initial success with the treatment. The authors indicate that there are primary patterns that should be treated first to assist the client in improving intelligibility. After acquisition of the primary patterns, intervention is directed to secondary targets. Primary patterns include: (1) Syllableness: Treat syllable structure patterns if client can't sequence syllables (e.g., baseball, chimney). Treatment is directed to syllable combinations, not exact consonant productions; (2) Prevocalic singleton consonants: Treat initial consonant deletions, if early appearing nasals /m, n/, stops /p, b, t, d/, and the labio-palatal glide /w/ are deleted; (3) Postvocalic singleton consonants: Treat postvocalic consonant deletions if voiceless stops /p, t, k/ and/or nasals /m, n/ are deleted; (4) Additional word structures: Treat cvc (e.g., boat) and vcv (e.g., abby) if problematic for the client. The same consonant configuration may facilitate cvc combinations (e.g., babe); (5) Fronting/Backing: Treat velar stops /k, g/ if substituted by alveolar stops /t, d/, or treat alveolar stops is substituted by velar stops; (6) /s/ clusters: Treat /s/ clusters if missing. /s/ clusters should be treated before singleton /s/ in cases of substitution of /t/ for /s/ and; (7) Liquids /r, l/: The liquids should be stimulated during each cycle if not used by the client.

The phonological awareness activities are varied and include phoneme identification tasks in isolation and word context, phoneme segmentation and blending and phoneme/grapheme manipulation (Gillon, 2000). The specific activities include: (1) development of rhyming skills; (2) identifying initial and final position sounds in words; (3) identifying similar sounds in different word items; (4) identifying a dissimilar sound among a group of words with a similar sound; (5)
segmenting sounds in words; and (6) linking speech to print by creating different words.

8. Velleman and Strand (1994) propose that practice in an individual session be divided into four different treatment activities:
   1. Begin the session with activities that require the client to imitate body and/or oral motor sequence patterns. This is a readiness activity for the activities that are to follow.
   2. Syllable sequence practice activities are then introduced with segmentals and syllable shapes that the child uses. Use sequences that differ according to articulatory position (/budugu/ or “buy two goats”) to vary practice and facilitate motor planning.
   3. Present single word items to build a core vocabulary of intelligible words.
   4. Introduce sentence practice frames as a production activity. Begin with a standard carrier phrase and change individual words, while manipulating the length and complexity of the sentences.

9. Bernhardt (1994) discusses a number of techniques based on nonlinear phonology that may be employed to develop syllable, word, and phrase structure. Some examples include the following:
   a. In some cases, children show restrictions in the number of phonemes that they use in the creation of syllables. Bernhardt recommends that the clinician create an awareness of various syllable and word units through listening activities such as poems that emphasize the syllable of interest. For instance, the clinician initially introduces a new syllable shape (CVC) that the client is not using via a poem. The target items are emphasized to create an awareness on the part of the child for the new syllable as opposed to the child’s existing shapes. Prior to presenting the poem, the child has been introduced to polar opposites such as big/little or long/short for the purpose of creating a contrast between and among syllable shapes (CV versus CVC). The new shape (CVC/long) can be contrasted with the existing shape (CV/short). The listening and awareness is then followed by production tasks. Bernhardt recommends that the child make the addition of segments to create CVC shapes from existing syllable shapes (mi → mit).
   b. In some cases, children will exhibit onset or rhyme restrictions. In nonlinear phonology, the syllable is divided into the onset and rhyme. The onset includes all segments before the resonating segment, which is generally the vowel or resonant nucleus of the syllable. The rhyme encompasses the resonating segment and all segments that follow. For example, /st/ is the onset and /ip/ is the rhyme in the word /stip/. If the client deleted the final consonant, treatment would be begin by creating an awareness of the onset and rhyme patterns. Bernhardt (1994) recommends descriptive terms such as “head” or “engine” for the onset and “body” or “coach” for the rhyme. This would be followed by contrasting different rhymes, so that the client is exposed to different ones such as the contrast between rhymes with only the resonating segment and rhymes with a final consonant segment (V versus VC). Initial production activities may begin with VC rhymes and the final consonant(s) may or may not be in the child’s inventory. This production
task would be followed by the introduction of onsets to the VC syllables (CVV).

10. Vowel errors (vowel neutralization and diphthongization) are seen frequently in the speech of children with CAS. The front vowels are /i, I, e, æ/ and they differ according to tongue height. The vowel pairs /i, I/ and /e, æ/) are made with about the same tongue position but one is tense and one is lax, which reflects tongue tension (tense) or lack of tension (lax). The muscular tension results in a production that has more intensity and is longer in duration than its lax counterpart. Constriction at the dorusrum area of the tongue results in the production of back vowels. An another important production feature of back vowels is that they are produced with lip rounding. The back vowels in order of high to low tongue height are /u, o, ə, ø, α/. The degree of lip rounding decreases with lowering of the tongue. The vowel pairs /u, o/ are tense/lax pairs. The central vowels /ʌ, ə/ are produced with the tongue positioned approximately in the center of the oral cavity as are the rhotic schwär and schwa. Diphthongs are produced by gliding from one vowel position to another. There is a slow gliding movement or vocalic transition from one vowel point (onglide) to another vowel point (offglide). The tongue elevates when moving from the onglide to the offglide position for English diphthongs. The diphthongs include /aɪ, əʊ, ɔɪ/.

There are some treatments that have been used to teach vowel production (Gibbon & Beck, 2002). Treatments will vary but some motor/articulatory treatment components include perception (Auditory identification and discrimination), and production of vowels from isolation to conversational speech and imitation to spontaneous elicitation. For example, the clinician presents models of the target vowel for the child to identify or discriminate depending on the activity. Some begin with isolated productions and then transition to nonsense words and/or real words during the perception stage of treatment. When the child is capable or discriminating/identifying the vowels, production trials are initiated for practice in different phonetic contexts and begin with imitation and lead to spontaneous use. The following method was developed by Ling and is discussed by Ruscello (2008).

1. Teach tongue-resting placement as in the position for the neutral vowel /ʌ/.
2. Introduce different vowel teaching subsets and conduct phonetic practice. One can pair tense/lax vowels or vowels that differ in terms of placement.
   A. Isolation practice.
   B. Practice sustained isolation.
   C. Practice in context of CV syllables.
3. Phonemic practice with the target vowel in contrast with other vowels.
4. Incorporate practice activities to facilitate target usage in spontaneous speech.
5. Introduce pitch variation in phonetic and phonemic teaching.
6. Modify teaching as a function of different vowel production errors.

11. If the child presents with a co-existing oral apraxia, treatment may be introduced to develop nonspeech isolated and sequential oral movements.
However, the clinician should be aware that there is no evidence to suggest that speech will improve through treatment of the oral apraxia. They are separate domains and require task specific treatment.
Appendix A

Sound System Assessment

<table>
<thead>
<tr>
<th>Place</th>
<th>Labial</th>
<th>Labiodental</th>
<th>Lingual-dental</th>
<th>Alveolar</th>
<th>Palatal</th>
<th>Velar</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop</td>
<td>p, b</td>
<td></td>
<td></td>
<td>t, d</td>
<td>k, g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>f, v</td>
<td>θ, ð</td>
<td>s, z</td>
<td>ñ, Z</td>
<td>h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affricate</td>
<td></td>
<td></td>
<td></td>
<td>tʃ, dZ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glide</td>
<td>w</td>
<td></td>
<td></td>
<td>j</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid</td>
<td></td>
<td></td>
<td>l</td>
<td>r</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vowels

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Central</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>i</td>
<td>u</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid</td>
<td>e</td>
<td>ñ, ð</td>
<td>o</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>α, ð</td>
<td>ð</td>
</tr>
<tr>
<td>Low</td>
<td>æ</td>
<td></td>
<td>a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lingual Movement</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low back to mid-high front position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low back to mid-high back position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low mid-back to mid-high front position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diphthongs

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>αI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>αU</td>
<td></td>
<td>ðI</td>
</tr>
</tbody>
</table>

Syllable Structures:

1. Simple Shapes V CV VC CVC
2. Complex Shapes consisting of cluster combinations such as CCV VCC CCVC CVCC CCCV CCCVC
3. Syllable Shapes of Multisyllabic Words

Prosody

Assess word and conversational utterances to determine if appropriate word stress, intonation contours, pause and inflection are employed. In the case of children with limited production capabilities have the child hum or engage in reiterant speech. For example, the child could be asked to hum a certain stress pattern of a presented utterance.
such as Happy Birthday, or use a reiterant speech syllable such as /ma/ or /ba/ in reproducing an utterance such as ‘‘Twinkle, twinkle, little star’’ would be reproduced as BAba BAba BAba BA.

Examples of pictured words to be produced by the child with a limited expressive vocabulary. Clinician points to a picture and provides the cue. “Say this word.


Appendix B

Intelligibility Estimation

Speech Intelligibility

Definition - capability of speaker to produce a spoken message that is understood by a listener.

Intelligibility Rating

A. You have conducted a sound system assessment and collected a conversational sample. You may not want to score the test so that you may observe. Another alternative would be to have one person score the test and the other rate intelligibility.

Severity rating (single words)

__ normal  __ mild  __ moderate  __ severe  __ profound

Rate the severity of the child’s speech sound impairment in conversation.

Severity rating (conversation):

__ normal  __ mild  __ moderate  __ severe  __ profound
THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993, updated 1996)

CONSONANTS (PULMONIC) © 1996 IPA

<table>
<thead>
<tr>
<th>Plosive</th>
<th>Bilabial</th>
<th>Labiodental</th>
<th>Dental</th>
<th>Alveolar</th>
<th>Postalveolar</th>
<th>Retracted</th>
<th>Palatal</th>
<th>Velar</th>
<th>Uvular</th>
<th>Pharyngeal</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plosive</td>
<td>p b</td>
<td>t d</td>
<td>t d</td>
<td>c j</td>
<td>k g</td>
<td>q g</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m m</td>
<td>n n</td>
<td>n n</td>
<td>n n</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trill</td>
<td>B G</td>
<td>r r</td>
<td>r r</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap or Flap</td>
<td>f f</td>
<td>g g</td>
<td>g g</td>
<td>h h</td>
<td>h h</td>
<td>h h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>φ β f v</td>
<td>θ ð s z</td>
<td>j ʃ s z</td>
<td>ζ j</td>
<td>x y</td>
<td>χ ξ h</td>
<td>h h</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral fricative</td>
<td>l l</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>v j</td>
<td>j j</td>
<td>j j</td>
<td>j j</td>
<td>j j</td>
<td>j j</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral approximant</td>
<td>l l</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

<table>
<thead>
<tr>
<th>Clicks</th>
<th>Voiced implosives</th>
<th>Ejectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilabial</td>
<td>b b</td>
<td>B B</td>
</tr>
<tr>
<td>Dental</td>
<td>d d</td>
<td>T T</td>
</tr>
<tr>
<td>Postalveolar</td>
<td>ѱ ѱ</td>
<td>D D</td>
</tr>
<tr>
<td>Alveolar lateral</td>
<td>f f</td>
<td>V V</td>
</tr>
</tbody>
</table>

OTHER SYMBOLS

| M | Voiceless labio-velar fricative |
| W | Voiced labio-velar approximant |
| U | Voiced labio-palatal approximant |
| H | Voiceless epiglottal fricative |
| ? | Voiced epiglottal fricative |
| Lateral fricative |

DIACRITICS

<table>
<thead>
<tr>
<th>Voiced</th>
<th>n d</th>
<th>breathed voiced</th>
<th>b a</th>
<th>Dental</th>
<th>t d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voiced</td>
<td>s c</td>
<td>Creaky voiced</td>
<td>b a</td>
<td>Apical</td>
<td></td>
</tr>
<tr>
<td>Aspirated</td>
<td>t h</td>
<td>Long glottal</td>
<td>t d</td>
<td>Nasal</td>
<td>n</td>
</tr>
<tr>
<td>More rounded</td>
<td>a w</td>
<td>Labelled</td>
<td>t w t w</td>
<td>Nasalized</td>
<td></td>
</tr>
<tr>
<td>Less rounded</td>
<td>a j</td>
<td>Palatalized</td>
<td>t d</td>
<td>Nasal release</td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>u Y</td>
<td>Velarized</td>
<td>t v t v</td>
<td>Lateral release</td>
<td></td>
</tr>
<tr>
<td>Retracted</td>
<td>e γ</td>
<td>Pharyngalized</td>
<td>t d t d</td>
<td>No audible release</td>
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</tr>
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</table>

VOWELS

<table>
<thead>
<tr>
<th>Front</th>
<th>Central</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>i * y</td>
<td>i * u</td>
</tr>
<tr>
<td>Close-mid</td>
<td>e • o</td>
<td>e • o</td>
</tr>
<tr>
<td>Open-mid</td>
<td>e • ë 3 • 3</td>
<td>A • ë</td>
</tr>
<tr>
<td>Open</td>
<td>æ • æ</td>
<td>æ • æ</td>
</tr>
</tbody>
</table>

Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Modern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Long</td>
<td>eː</td>
</tr>
<tr>
<td>2: Half long</td>
<td>eˈ</td>
</tr>
<tr>
<td>3: Extra-short</td>
<td>ê</td>
</tr>
<tr>
<td>4: Minor (foot) group</td>
<td></td>
</tr>
<tr>
<td>5: Major (intonation) group</td>
<td></td>
</tr>
<tr>
<td>6: Syllable break</td>
<td>øækt</td>
</tr>
<tr>
<td>7: Linking (absence of a break)</td>
<td></td>
</tr>
</tbody>
</table>

TONES AND WORD ACCENTS

<table>
<thead>
<tr>
<th>Level</th>
<th>Contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra high</td>
<td>e or E</td>
</tr>
<tr>
<td>High</td>
<td>e Y</td>
</tr>
<tr>
<td>High rising</td>
<td>e E</td>
</tr>
<tr>
<td>High falling</td>
<td>e E</td>
</tr>
<tr>
<td>Low</td>
<td>e Y</td>
</tr>
<tr>
<td>Low rising</td>
<td>e E</td>
</tr>
<tr>
<td>Low falling</td>
<td>e E</td>
</tr>
<tr>
<td>Downstep</td>
<td>ø</td>
</tr>
<tr>
<td>Uptop</td>
<td>ø</td>
</tr>
</tbody>
</table>

Rhoticity | e a | Retracted Tongue Root | e
| Name: ________________________________________ | Date: __________________________ |
| Place – Voice – Manner | Transcriber: ______________________ |
| Error Pattern Analysis |

| m | n | ñ | p | b | t | d | k | g | ð | ō | f | ʋ | s | z | ʃ | ʒ | ɜ | h | tʃ | dʒ | l | r | w | j |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

<table>
<thead>
<tr>
<th>Nasals</th>
<th>Stops</th>
<th>Fricatives</th>
<th>Affricates</th>
<th>Liquids</th>
<th>Glides</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>nasal clusters</th>
<th>/l/ clusters</th>
<th>/r/ clusters</th>
<th>/w/ clusters</th>
<th>/s/ clusters</th>
<th>Phonetic inventory</th>
<th>P.V.M. Error Patterns</th>
</tr>
</thead>
</table>
Appendix C

Oral Motor Examination

1. Oral and Speech Motor Control Protocol

<table>
<thead>
<tr>
<th>Lips (CN VII)</th>
<th>Speech Function:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure at rest:</td>
<td>38. Elevation to alveolar ridge:</td>
</tr>
<tr>
<td>1. Symmetry</td>
<td>/n/, /t/, or /l/</td>
</tr>
<tr>
<td>2. Relationship (open vs. closed) Oral function:</td>
<td>39. Touch lateral edges of tongue to teeth: /s/ or /l/</td>
</tr>
<tr>
<td>3. Rounding</td>
<td>40. Interdental: /O/</td>
</tr>
<tr>
<td>4. Protrusion (blowing)</td>
<td>41. Posterior tongue to palate: /k/ or /g/</td>
</tr>
<tr>
<td>5. Retraction</td>
<td>Velopharynx (CN X)</td>
</tr>
<tr>
<td>6. Alternate pucker/smile</td>
<td>Structure at rest:</td>
</tr>
<tr>
<td>7. Bite lower lip</td>
<td>42. Symmetry</td>
</tr>
<tr>
<td>8. Lip seal</td>
<td>43. Uvula</td>
</tr>
<tr>
<td>9. Puff cheeks</td>
<td>44. Tonsils</td>
</tr>
<tr>
<td>10. Open close lip</td>
<td>45. Vault height</td>
</tr>
<tr>
<td>Speech function:</td>
<td>46. Palatal juncture (palpate)</td>
</tr>
<tr>
<td>11. Rounding /o :/</td>
<td>Oral function:</td>
</tr>
<tr>
<td>12. Protrusion /u:/</td>
<td>47. Blow on cold mirror</td>
</tr>
<tr>
<td>13. Retraction /i:/</td>
<td>48. Suck through straw</td>
</tr>
<tr>
<td>14. Alternate /u/, /i/</td>
<td>Speech function:</td>
</tr>
<tr>
<td>15. Bite lower lip /i/</td>
<td>49. /a:/</td>
</tr>
<tr>
<td>16. Open close lips /m /</td>
<td>50. /ha.ha.ha/</td>
</tr>
<tr>
<td>Mandible (CN V)</td>
<td>Larynx-Respiration (CN X)</td>
</tr>
<tr>
<td>Structure at rest:</td>
<td>Structure at rest:</td>
</tr>
<tr>
<td>17. Symmetry</td>
<td>51. Posture during quiet breathing</td>
</tr>
<tr>
<td>18. Occlusion</td>
<td>Oral function:</td>
</tr>
<tr>
<td>19. Size (re: facial features)</td>
<td>52. Cough, laugh, or cry</td>
</tr>
<tr>
<td>Oral function:</td>
<td>Speech function:</td>
</tr>
<tr>
<td>20. Excursion (click teeth 5x)</td>
<td>81. Maximum phonation time (in seconds): /a:/</td>
</tr>
<tr>
<td>Maxilla</td>
<td>53. Pitch variation</td>
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<tr>
<td>Structure at rest:</td>
<td>54. Loudness variation</td>
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<tr>
<td>21. Symmetry</td>
<td>55. /ha.ha.ha/</td>
</tr>
<tr>
<td>22. Size</td>
<td>Coordinated speech movements</td>
</tr>
<tr>
<td>Teeth</td>
<td>56. (82)a /p / repetitions</td>
</tr>
<tr>
<td>23. Decay</td>
<td>57. (83)a /t / repetitions</td>
</tr>
<tr>
<td>24. Alignment</td>
<td>58. (84)a /k / repetitions</td>
</tr>
<tr>
<td>25. Gaps</td>
<td>59. (85)a /p r k k/</td>
</tr>
<tr>
<td>26. Missing</td>
<td>repetitions</td>
</tr>
<tr>
<td>27. Occlusion (re: maxillary teeth)</td>
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</tbody>
</table>
28. Symmetry 60. (86)a patticake repetitions
29. Carriage 61. you
30. Fasciculations 62. top
31. Furrowing 63. beef
32. Atrophy 64. fume
33. Hypertrophy 65. cowboy
Oral function: 66. band-aid
34. Protrusion 67. half time
35. Elevation to alveolar ridge 68. banana
36. Anterior-posterior sweep 69. kitty cat
37. Interdental 70. puppy dog
71. communicate
72. 1950
73. potato head
74. Winnie the Pooh
Speech sample
Prosody:
75. Rate
76. Intonation
Voice:
77. Pitch
78. Loudness
79. Quality
80. Nasal resonance

a Items 56-60 are scored for articulatory accuracy, and Items 82-86 for mean number of repetitions per second over 3 s.

Source: Robbins & Klee (1987)

2. Assessment of Resonance

I. Nasality Parameters-Definitions
   A. Hypernasality
   B. Hyponasality

The most common way to assess nasality is to provide some perceptual evaluation in the form of a rating scale. Rating scales are problematic since reliability is a problem, but they are useful in providing a perceptual index.

II. Rating Scales-Hyper/Hypo
   A. Nasal Flutter Test
   B. Typical Rating Scales

   A. Resonance:_______ Normal_______ Abnormal
B. If abnormal, is speech excessively _____ Hypernasal _____Hyponasal _____ Both

Appendix D

Morphophonemic Alterations

<table>
<thead>
<tr>
<th>Word</th>
<th>Initial Form</th>
<th>Initial Modification</th>
<th>Final Modification</th>
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<td>battery</td>
<td></td>
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</table>

Multisyllabic Words of two, three and four syllables for imitative repetition.

25. Alternative

Word List- Repetition


Word, phrase, and sentence repetition stimuli.

1. Dog-a dog-a big dog- I see a big dog.
2. Bird- a bird-a happy bird-That is a happy bird.
3. Car-a car- a big car-a big blue car-A big blue car is nice.
4. Play- I play- I play ball-I play ball outside
5. Bike-my bike-my birthday bike-My birthday bike was a present.

Appendix E

Volitional Oral Movements
1. Stick out your tongue.
2. Blow.
3. Show me your teeth.
4. Touch your nose with tongue.
5. Bite your lower lip.
6. Show how you whistle.
7. Lick your lips
8. Clear your throat.
9. Move your tongue in and out.
10. Click your teeth once.
11. Smile for me.
12. Click (pop) your tongue.
13. Chatter teeth as if cold.
14. Touch chin w/tip of tongue
15. Cough.
16. Puff out your cheeks.
17. Wiggle tongue from side to side.
18. Show how you kiss someone

1. Show me your teeth and then puff out your cheeks.
2. Smile and then click your teeth once.
3. Lick your lips and then blow.
4. Bite your lower lip and then wiggle tongue from side to side.
5. Clear your throat and then touch your nose with tongue.
6. Smile, puff out your cheeks, and then cough.
7. Lick your lips, clear your throat, and then stick out your tongue.
8. Show your teeth, wiggle your tongue from side to side, and then blow.

Possible Scoring options:

1. Accurate. 2. Accurate following trial and error. 3. Part of command carried out. 4. Inaccurate. 5. No response.

Appendix F

Self-talk and Parallel-talk

Both of the procedures are child-oriented approaches wherein the parent takes the lead from the child. The procedure, self-talk has the parent discuss interactions during play activities with the child. The child is not asked to respond, the parent simply
comments on the activities being carried out by the child. In utilizing parallel-talk the parent makes assertions concerning the actions and objects that their child is attending to. They provide a commentary in regard to what the child is doing and share the same focus with the child. The parents use simplified forms of grammatical and semantic forms in their parallel-talk.

Self-talk

“I’m playing. See my car. It’s little.”

Parallel-talk

The child is playing with a doll and the clinician comments on the activity.

“I see the doll. It is pretty. I like the doll.”

Expansions

Expansions are used to expand upon what the child has said. The purpose is to add grammatical detail and expand semantic functions. If a one-word response has been provided by the child, the parent may verify the response and expand upon it by adding other words. Research suggests that children exposed to expansion techniques do indeed start to imitate a part or the entire expansion. This is a good technique to use in teaching parents to work with their children.

Expansion

The child says “throw” and then the parent says, “yeah, you throw ball.”

Expatiations

Expatiations are also known as extensions and are expanded versions of a child’s response but the purpose is to add new information to what the child has said. That is, the idea is to add semantic detail

Expatiation

The child says “kitty” while placing the toy in a playhouse. The parent responds, “The kitty is in the house.” or “The kitty is soft and pretty.”

Recast Sentences

Recast sentences are a form of expansion wherein the child’s utterance is recast in another sentence form. For example, if the child used a declarative sentence, the parent might counter with a question. One type of recast that appears to be helpful with some children is the verbal reflective question. The idea is to continue the verbal interaction
with the child and continue a communication interaction.

Recast Sentences

The child says “throw ball” and the parent follows with “Did you throw the ball?”

Reflective Question

The child says “throw ball” and the parent follows with “You threw the ball, didn’t you?”

Appendix G

Baby Sign Language Resources

Books
1. Baby Sign Language Basics
   Early Communication for Hearing Babies and Toddlers
   By: Monta Z. Briant
2. Baby Signing 123
   The Easy-to-Use Illustrated Guide for Every Stage and Every Age
   By: Nancy Cadjan
3. Baby Talk
   A Guide to Using Basic Sign Language to Communicate with Your Baby
   By: Monica Beyer
4. Signing Smart with Babies and Toddlers
   A Parent’s Strategy and Activity Guide
   By: Michelle E. Anthony & Reyna Lindert
5. Baby Sign Language For Hearing Babies
   By: Karyn Warburton
6. Sign, Sing, and Play
   Fun Signing Activities for You and Your Baby
   By: Monta Z. Briant
7. A Parent’s Guide to the Baby Signs Program
   By: Dr. Linda Acredolo & Dr. Susan Goodwyn
8. Sign with your Baby
   How to communicate with infants before they can speak
   By: Dr. Joseph Garcia
9. Teach Your Tot to Sign
   A Parent’s Guide to American Sign Language
   By: Stacy A Thompson
10. Baby Signing
    How to talk with your baby in American Sign Language
    By: Andrea Fixell & Ted Stafford
11. Baby Signing for Dummies
By: Jennifer Watson
   By: Diane Ryan

**Online References**
1. iCANsign       www.icansign.ca
2. Sign 2 Me       www.sign2me.com
3. My Baby can Talk www.mybabycantalk.com
4. You can order other resources such as DVD’s through www.signingtime.com
References


