Treatment of Childhood Apraxia of Speech
Part 1

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DISCLOSURE STATEMENT

There is a relevant financial relationship to disclose. I am an invited speaker and will receive an honorarium, travel and hotel from ISHA.
CAS (ASHA, 2007)

• CAS is a childhood speech sound disorder!

• precision & consistency of movements underlying speech are impaired

• absence of neuromuscular deficits

• core impairment in planning of movement sequences

• errors in speech sound productions

• prosody issues
ETIOLOGY

- idiopathic
- result of neurological impairment
- co-occurring with other disorders (Down Syndrome, ASD, 22q11.2 deletion, etc.)

- 1-2% of average SLP caseload (ASHA, 2007) (recent numbers are 3% to 5%)
CAS KEY INDICATORS
(Strand 2005; ASHA 2007; Davis, Jakielski, & Marquardt 1998)

1. difficulty achieving & maintaining articulatory configurations

2. vowel deviations

3. limited V, C, SS repertoires

4. difficulty completing movement & sequencing gestures of sounds in a complex linguistic context, even though sounds easily produced in a simple context
ASHA CONSENSUS-BASED FEATURE LIST (Murray et al., 2015)

• inconsistent errors on consonants and vowels in repeated productions of syllables or words
• lengthened and disrupted co-articulatory transitions between sounds and syllables
• inappropriate prosody, especially in the realization of lexical or phrasal stress
10-POINT CHECKLIST (Strand, 2009; Shriberg, Potter, Strand, 2011)

1. difficulty achieving initial articulatory configurations and transitions into vowels
2. syllable segregation
3. lexical stress errors or equal stress
4. vowel or consonant distortions including distorted substitutions
5. groping (non-speech)
6. intrusive schwa
7. voicing errors
8. slow rate
9. slow DDK rate
10. increased difficulty with longer or more phonetically complex words
CAS SUPRASEGMENTAL ISSUES

• lack of ‘naturalness’ in connected speech
• lack of prosodic variation/ intonation
• excessive or equal stress in multisyllabic words
• volume issues
• poor rhythm, timing & rate
NON-SPEECH MOTOR SIGNS OF CAS
(DAVIS ET AL, 1998; SHRIBERG ET AL, 1997A

• oral apraxia (groping/posturing)
• general awkwardness or clumsiness
• impaired volitional oral movements
• mild delays in motor development
• mildly low muscle tone
• hyper- or hyposensitivity in oral cavity area
SUSPECTED CHILDHOOD APRAXIA OF SPEECH (sCAS)

• typically very young children (up to age 3 & sometimes 4) who are developing speech and expressive language
• exhibits several key indicators of CAS
• questionable diagnosis of CAS
POSSIBLE INFANT/TODDLER EARLY CHARACTERISTICS OF CAS
(DAVIS & VELLEMAN, 2000; CASPARI & JAKIELSKI, 2010)

- lack of strong canonical babbling
- low verbalizations
- uses more gestures & made-up signs
- words emerge, then disappear
- early feeding issues, drooling, oral apraxia
- limited V & C productions; lack variety of V & C
- produces isolated V or C for a “word”; low # of syllable structures
- sound preferences; syllable preferences
- limited intonation
- quiet infant; late cooing; late babbling
- late onset first words
DIAGNOSIS-ASHA, 2007

- Use phrasing: “CAS cannot be ruled out, signs are consistent with CAS, or suspected to have CAS”
- Cautions in CAS diagnosis especially due to the challenges associated with diagnosis of younger children
- Suggest a period of trial intervention prior to diagnosis
- Research has not addressed the question of the youngest age at which a diagnosis of CAS can be valid and reliable
- Clinical guidelines on the appropriate minimum age for the diagnosis of CAS appear to range from under 2 years of age to under 4 years of age, including both children with idiopathic CAS and with CAS as a secondary symptom in neurological and complex neurobehavioral disorders
CHALLENGES WITH CAS DIAGNOSIS

• lack diagnostic guidelines
• child does not have enough speech to make judgment--need speech output or attempts
• typical early speech acquisition includes many CAS characteristics: omissions, inconsistent productions, emerging C & V
• speech that is highly unintelligible with numerous phonological errors
• child uses a significant amount of jargon
• child has very low expressive language skills or has other significant delays/other disorders
CAS IS DYNAMIC

Changes can occur due to –

▪ maturing motor & neurological systems

▪ treatment progress
Comparison CAS & Phonological Disorder (www.apraxia-kids.org)

**CAS**

- Inconsistencies in articulation performance—the same word may be produced several different ways
- Errors include substitutions, omissions, additions and repetitions, frequently includes simplification of word forms. **Tendency for omissions in initial position. Tendency to centralize vowels to a “schwa”**.

**Severe Phonological Disorder**

- Consistent errors that can usually be grouped into categories (fronting, stopping, etc.)
- Errors may include substitutions, omissions, distortions, etc. Omissions in final position more likely than initial position. **Vowel distortions not as common**.
Comparison CAS & Phonological Disorder (www.apraxia-kids.org)

**CAS**
- Number of errors increases as length of word/phrase increases
- Well rehearsed, “automatic” speech is easiest to produce, “on demand” speech most difficult
- Rate, rhythm and stress of speech are disrupted, some groping for placement may be noted

**Severe Phonological Disorder**
- Errors are generally consistent as length of words/phrases increases
- No difference in how easily speech is produced based on situation
- Typically no disruption of rate, rhythm or stress

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RESIDUAL ERRORS OF OLDER CHILDREN WITH CAS

- vowel errors
- multisyllabic word errors
- prosody issues (rate, intonation, stress)
- self-monitoring / carryover issues
- persistent sound errors
- intelligible speech with errors still present
DYSARTHRIA---SPEECH

• affects respiration, phonation, articulation, resonance, prosody
• sound distortions
• slow rate of speech; problems with speed
• poor stress use
• reduced strength of articulatory contacts
• reduced range of movement of articulators
• reduced respiratory coordination; strained or breathy speech
• connected speech is often unintelligible
ASSESSMENT
Speech Assessment CAS

• formal articulation/phonology test
• repeated productions of the same target sound or word
• compare imitation vs. spontaneous productions
• stimulability testing
• connected speech sample (speech intelligibility)
• oral motor exam/oral apraxia check
Speech Assessment CAS

• vowel & consonant analysis (isolation, word, connected speech)
• Percentage of Consonants Correct (PCC) & Percentage of Vowels Correct (PVC)
• DDK (buttercup) (repeat several times)
• compare a sound or a word in several contexts (1 word, in 2 words, in 3 words—beginning/mid/end of phrase)
• Consistency assessment (i.e. DEAP test)
• multisyllabic word check (Hodson Multisyllabic Word Screener)
• CAS Characteristics Checklist
CAS CHECKLISTS

- CAS Checklist & Prognostic Checklist (Hoffmann 2014)
- Checklist of CAS Characteristics (Fish 2016)
- Motor Speech Evaluation Analysis Form (Fish 2016)
FORMAL ASSESSMENT

• *Dynamic Evaluation of Motor Speech Skill (DEMSS).* (Strand, & McCauley 2019) (Age Range: ages 3 and older who have severe SSD’s with reduced phonemic/phonetic inventories, vowel errors, and/or minimal verbal output.)

• *Kaufman Speech Praxis Test (KSPT)* (Kaufman) (Age Range: 2:0 to 5:11)

• *Verbal Motor Production Assessment for Children (VMPAC)* (Hayden & Square, 1999) Age Range: 3:0 to 12:0
FORMAL ASSESSMENT

• **Goldman-Fristoe Test of Articulation-3 (GFTA-3)** (Goldman & Fristoe 2015) (Age Range: 2:0 to 21:11)

• **Hodson Assessment of Phonological Patterns-3 (HAPP-3)** (Hodson 2004) (Age Range: 2:0 to Adult; Normative data for 3:0 to 8:0)

• **Diagnostic Evaluation of Articulation and Phonology (DEAP)** (Dodd et al. 2006) (Age Range: 3:0 to 8:11)

• **Arizona Articulation Proficiency Scale-3 (Arizona 3)** (Fudala 2000) (Age Range: 1.5 to 18)
ORAL MOTOR EXAM

- oral-motor-structural exam (dentition, lips, hard palate, alveolar ridge, soft palate, tonsils, uvula, tongue, gag reflex, etc.)
- oral apraxia exam (non-speech tasks—sequence a few tasks)(Velleman 2003—adapted from K. Strand 1997) (blow, show teeth, lick lips, click tongue, pucker lips, cough, bite lower lip, smile then pucker, etc.)
- quick oral motor imitation check (open mouth, close lips, bite lip, round lips, close teeth)
- drooling? bruxism?
OTHER TESTING

• connected speech sample: note speech intelligibility; observe voice, fluency, prosody
• standardized receptive and expressive language testing
• phonological/phonemic awareness testing
• hearing screening
Speech Assessment for Minimally Verbal Children -- sCAS

• vowel inventory (isolation, syllables with known consonant to check for integrity of vowel across syllables)
• consonant inventory (isolation—try NOT to add vowel with consonant; syllables with known vowel)
• syllable structures (look at all testing completed---imitated and spontaneous)
• *MacArthur-Bates CDI: Words and Gestures*
• play scale and speech / language sample
•“The gold standard for CAS diagnosis remains expert clinical opinion.”
(Murray et al. 2015)
TREATMENT OF CAS
Should we separate out articulation, CAS, and phonological approaches??

We do not necessarily want to silo these approaches out completely!
Motor speech disorders require repetitive planning, programming, and production practice; therefore, intensive and individualized treatment of childhood apraxia is often necessary.

Most treatment approaches for CAS put an emphasis on sound movement sequencing.

Many approaches incorporate traditional sound facilitation techniques (i.e., sound placement, specific instructions, shaping, etc.) or functional core vocabularies.

As characteristics of CAS vary from child to child, use of multiple approaches may be necessary and appropriate.
ASHA Practice Portal: CAS (2016)

VARIED TREATMENT APPROACHES THAT ARE BENEFICIAL FOR CAS

• motor-programming approaches (Integral Stimulation; DTTC; etc.)
• linguistic approaches (phonological awareness; AAC; phonological; etc.)
• combination approaches use both motor-programming and linguistic approaches (i.e. training syllable sequences; etc.)
• sensory cueing approaches (i.e. tactile cues; PROMPT; visual cues; etc.)
• rhythmic (prosodic) approaches (i.e. MIT; prosody facilitation; etc.)
MOTOR LEARNING FOR SPEECH TREATMENT
FOCUS OF TREATMENT

• To improve the individual’s ability to assemble, retrieve, and execute motor plans for speech (Strand, 2012)
• focus on MOVEMENT of sounds
• segmental & suprasegmental issues
• practice meaningful, connected speech
• make therapy DIFFICULT during early learning to maximize results/cause the most change
MOTOR PERFORMANCE & LEARNING

• practice facilitates motor performance
• Child needs experience with motor learning (using skilled action)
• want motor learning to be permanent
• repetitive motor drill is important—want to habituate motor learning
MOTOR LEARNING
(YORKSTON ET AL., 2010)

“SLP’s facilitate the child’s ability to develop motor skills for speech----provide modeling, practice, and therefore experience of the movement skills, so learning & retention of motor skills occur.”
AUTOMATICITY VS. FLEXIBILITY--VELLEMAN & STRAND, 1994

• Appropriate to increase automatic speech (animal sounds, words, predictable books)...yet it does not address “fundamental organizational problem of CAS”

• Drill of specific words/phrases (to become automatic)---is not enough---need to do more for the client

• Increase flexibility....challenge the speech system---gradual, slower, systematically
“FLEXIBILITY”
VELLEMAN & STRAND, 1994

• Want to teach “syllable structure control & organization within a variety of dynamic linguistic contexts”
• Varied sequences of syllables, words, sentences
• Expand oral motor organizational capability
• Increase ability to handle new speech tasks
• Go to more naturalistic activities after some drill
SYLLABLE MOVEMENT SEQUENCES

• movement from one consonant position to varied vowel positions (i.e. me, my, mow, moo, may)
• movement from varied consonant positions to one vowel position (i.e. me, bee, pea, key, see, knee, we, tea, D)
• want to keep moving these shapes....longer and more complex—CV, CVCV, CVCVCV, and more
• use consonant chart and vowel quadrilateral to create syllables
GRIGOS, MOSS & LU (2015) RESEARCH

• Study looking at oral articulatory control in CAS with 33 children between 3 and 7 years of age tracking jaw and lower/upper lip movements during a naming task (compared to typical development and artic/phono impairment)

• Results indicated significantly higher movement variability in children with CAS—especially as word length increased

• Relates to CAS impairment in planning & programming speech movements and key diagnostic indicators of inconsistent productions and difficulty completing movement & sequencing gestures of sounds in complex linguistic contexts
MORE ON MOTOR ASPECTS OF TREATMENT

• practice makes permanent
• must work on speech to improve speech
• overall sound system fatigue can be an issue during practice
• alternate practice with varied patterns....better generalization occurs
FOUR PRINCIPLES OF MOTOR LEARNING
(Gildersleeve-Neumann, 2007)

1. precursors to motor learning
2. conditions of practice
3. feedback
4. effects of rate
PRECURSORS TO MOTOR LEARNING (Caruso & Strand 1999)

• motivation (i.e. frustration with not being understood; enjoys speaking; desire to communicate)
• focused attention & effort
• ability to follow instructions in therapy
• ability to imitate a model
MASS VS. DISTRIBUTED / VARIABLE & RANDOM VS. BLOCKED PRACTICE

- **mass practice** = same utterance/quick learning/little generalization
- **blocked**: one stimuli practiced repeatedly; separate sound practice
- **distributed/variable practice** = slower learning/more generalization
- **random**: stimuli are mixed through session and practiced a few times (better for motor learning)
- Sometimes we start with block practice and move to random practice in therapy
- Avoid using one utterance too much (mass practice) or too many utterances (difficult for child)
- Use smaller sets when targeting functional words/phrases---then increase to larger sets

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Blocked—predictable order—work across or up and down (DeMarco & Hammer, 2019)

• No no no no no

• go go go go go

• Car car car car car
Random—unpredictable order—work across or up and down (DeMarco & Hammer, 2019)

- Batman  Batman  Batman  No
- No  Batman  No  Batman
- Go  Batman  Go  Batman
- Go  Car  Batman  Help

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CONDITIONS OF PRACTICE
(Caruso & Strand, 1999)

• vary the length & linguistic complexity of targets
• use repetitive practice
• child as an active participant---knows what to expect in therapy & why he is doing tasks
• mass vs. distributed/variable practice (upcoming slide)
• random vs. blocked practice (upcoming slide)
<table>
<thead>
<tr>
<th><strong>PRACTICE PRINCIPLE</strong></th>
<th><strong>INCREASE ACQUISITION</strong></th>
<th><strong>ACHIEVE RETENTION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>distributed</strong></td>
<td>mass practice (use in few sessions)</td>
<td>distributed (use in more sessions)</td>
</tr>
<tr>
<td><strong>variable</strong></td>
<td>consistent context</td>
<td>varied context</td>
</tr>
<tr>
<td><strong>schedule</strong></td>
<td>blocked (builds foundation); predictable</td>
<td>random (mix it up); unpredictable</td>
</tr>
<tr>
<td><strong>feedback type</strong></td>
<td>performance knowledge (extrinsic feedback)</td>
<td>result knowledge</td>
</tr>
<tr>
<td><strong>feedback frequency</strong></td>
<td>often; immediate</td>
<td>inconsistent; delayed</td>
</tr>
<tr>
<td><strong>rate</strong></td>
<td>slow</td>
<td>normal; varied</td>
</tr>
</tbody>
</table>

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MAAS & FARINELLA 2012 RESEARCH

• Compared random vs blocked practice in CAS treatment with 4 clients using a DTTC approach

• Findings were mixed---2 children showed a blocked practice advantage
  ---1 child showed a random practice advantage
  ---1 child showed no clear improvement
Study looked at the importance of production frequency in therapy for CAS by using variable practice and presented in random block trials and noting the effects of treatment intensity on performance and carryover of target sounds (with 2 clients)

High frequency practice condition (100-150 trials per 15 minutes) (compared to moderate frequency practice of 30-40 trials per 15 minutes)

Results indicated rapid acquisition of speech targets
SKELTON & HAGOPIAN (2014) RESEARCH

• Study looking at using randomized variable practice in the treatment of CAS with 3 children aged 4 to 6 years of age by changing up response length

• Results indicated an increase in correct productions during imitated and non-imitated word, 2 word phrases and 3 word phrases
Method options for ordering practice tasks:

1. **blocked**: teaching targets in the same practiced task until it is taught to criterion
2. **random**: shifting the practice task after each trial
3. **combination of both**: having the order of practice tasks randomized and each task practiced a specified number of trials before moving to the next task

(Skelton & Hagopian 2014)
Practice Research—Maas et al. (2019)

• “High practice amount and massed practice were associated with more robust speech motor learning in most children with CAS (compared to low practice amount and distributed practice), using integral stimulation treatment for CAS.”

• Study of 6 children

• efficacy of integral stimulation treatment for CAS
SPECIFIC FEEDBACK

- use clear data & facts about performance
- non-judgmental yet descriptive
- provide opportunity to self-correct!
- continuous vs. intermittent feedback
- use quick, highly motivating token reinforcement that does not distract
- use auditory feedback (i.e. Language Master; Quick Voice on iPad)
SPECIFIC FEEDBACK

• teach client how to fix his own errors so self-corrections can even occur
• do comprehension checks to make sure child understands your specific feedback
ERROR RECOGNITION

• Teach client how to:
  – “recognize & hear” own errors
  – “describe” own errors
  – “feel” own errors
  – “scroll” through possible corrections
  – “correct” own errors
PRACTICE ERRORS

• go through exact steps that a client does when producing the error sound---break it down in slow motion (in mirror)
• practice sound in error a few times
• increase awareness to errors and what is really happening during production
• then.....explain what should really occur in producing the sound
• slowing the rate may help child get more kinesthetic feedback with movements of articulators (use different terminology)
• may help child pay more attention to actual productions & provide time to motor plan
• try easy speech/stretchy speech
• establish faster articulatory movements over time
• practice difficult words several times
• want productions to sound natural/automatic
SELF-MONITORING

• Start teaching self-monitoring very early in therapy
• *explicitly* teach kids with CAS how to self-monitor
• use foils (purposeful errors) & model self-corrections with self-talk
• help child initiate repairs
• explain to client how we all monitor our speech *constantly* & check for errors--we interrupt ourselves & make self-corrections

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MURRAY, MCCABE & BALLARD (2014) RESEARCH REVIEW OF TREATMENT FOR CAS

• looked for evidence of efficacy with CAS treatment
• analyzed motor approaches, linguistic approaches, AAC approaches
• 3 approaches were deemed best for clinical use:
  • Integral Stimulation/DTTC (Stand & Debertine 2000; Edeal & Gildersleeve-Neumann 2011; Maas & Farinella 2012)
  • ReST (Rapid Syllable Transition Treatment) (Ballard et al. 2010)
  • Integrated Phonological Awareness Intervention (Moriarty & Gillon 2006; McNeill et al. 2009)
DYNAMIC TEMPORAL & TACTILE CUEING-DTTC
(Strand & Skinder 1999; Strand 2008)

- uses principles of motor learning to achieve motor learning
- dynamic, cognitive approach
- uses simultaneous verbal productions
- uses visual stimuli (sound hand signals, written cues)
- uses tactile stimulation-- ‘feel’ the movement (kinesthetic cues)
DTTC CONTINUED
(Strand & Skinder 1999; Strand 2008)

- uses imitated utterances increasing in length & complexity
- encourages use of functional vocabulary
- can choose # of stimuli for each client
- recommends minor physical changes in therapy (moving hands, shifting body)
- intensive drill / eye contact important
- *high level* of success critical
- increases intrinsic motivation
DTTC STEPS
(Gildersleeve-Neumann 2007)

1. client watches & listens & simultaneously produces the stimulus with SLP
2. SLP models; client repeats the stimulus while SLP simultaneously mouths it
3. SLP models & provides cues; client repeats
4. SLP models; client repeats with no cues provided
5. SLP elicits stimulus w/o modeling (i.e. picture cards; ask ?’s; fill-ins)
6. client produces stimulus in less-directed situations (i.e. game; book; role-play)
BODY POSITION CHANGES IN PRACTICE

• increases practice, attention, simultaneous motor movements, challenges jaw & tongue stability, body & head stability
  • walk up & down steps
  • stand/stand with knee on chair
  • sit on therapy-ball, bean bag chair, sensory cushion
  • sit with back against chair or wall
  • feet on floor or on stool
DISTRACTIONS

• benefits of distractions (when? how much?)
• change body positioning (i.e. therapy ball, bean bag chairs, etc.)
• whispered speaking/louder speaking
• purposeful slower vs. faster speaking
• increase complexity of activity itself (i.e. more challenging game; more thinking involved)
“Rapid Syllable Transition Treatment (ReST) applies principles of motor learning to maximize long-term maintenance and generalization of speech skills in children with CAS. ReST involves intensive practice in producing multisyllabic, phonotactically permissible pseudo-words to improve accuracy of speech sound production, rapid and fluent transitioning from one sound or syllable to the next, and control of syllable stress within words. Pseudo-words are used to allow the development and practice of new speech patterns without interference from existing error speech patterns (Murray, McCabe, & Ballard, 2012).” —ASHA 2016
Integrated Phonological Awareness Intervention (Gillon & McNeill 2007)

“This integrated phonological awareness intervention is designed for the simultaneous facilitation of speech production, phonological awareness and letter-sound knowledge in preschool and young school aged children with speech and language impairment. This intervention is based on activities implemented in the Gillon (2005), Moriarty and Gillon, (2006) and McNeill (2007) intervention studies. The findings from these research investigations indicated that the program was effective in facilitating significant improvement in speech production, early reading and spelling development in preschool children with speech impairment and in children aged 4-7 years diagnosed with childhood apraxia of speech.”
DALE & HAYDEN (2013) RESEARCH PROMPT APPROACH

• PROMPT: Prompts for Restructuring Oral Muscular Phonetic Targets

• uses tactile-kinesthetic-proprrioceptive (TKP) cues which support and shape movements of the articulators

• Study: 4 clients with CAS—8 weeks treatment

• results indicated that clients made significant gains during trmt with motor speech control and with untreated word probes when cues provided

• inclusion of TKP cues “facilitated greater effect”
THANK YOU!

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REFERENCES


• [www.apraxia-kids.org](http://www.apraxia-kids.org)