

**Diagnosis and Management of Childhood Apraxia
of Speech (CAS) using
Dynamic Tactile and Temporal Cueing (DTTC)**

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DISCLOSURE

Non-financial
Dr. Strand is on the Advisory Board for the Childhood
Apraxia of Speech Association of North America
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INTRODUCTION

Most Important Points to Take Away!

- CAS is a label for a type of speech sound disorder
 - not a medical diagnosis

- The focus or target of treatment for CAS is the movement – versus the sound ---And that changes **EVERYTHING**

- Differences in approaching treatment include
 - ❑ More frequent therapy
 - ❑ Using an approach focused on improving motor skill
 - ❑ Incorporate the principles of motor learning (PML)

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➤ Specific examples of some of these differences:

- ❑ Create specific stimuli based on vowel content and syllable shape during early treatment

- ❑ With more severe praxis deficits, use fewer stimuli, with more dynamic “shaping” of the movement accuracy

- ❑ Maximize response trials per session
 - Rather than pictures or games, use quick reinforcers
 - Maximize their ability to look at your face

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- ❑ Use a modified block approach, moving to more random as the utterance becomes accurate

- ❑ Give frequent specific feedback at first – moving to less specific and less feedback as accuracy improves

- ❑ Use probe testing (vs. treatment data) to measure progress

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And for Sure

- **Make sure you have a rationale for each clinical decision you make**
- **Be confident in your ability to explain that decision to parents and others**

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A brief review of differential diagnosis leading to treatment planning

- Although this course is focused on treatment, differential diagnosis is the first step in treatment planning
- That means – distinguishing children with respect to the relative contribution of
 - phonologic impairment
 - CAS-- and/or
 - dysarthria

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Brief Intro to CAS

- Believed to be due to deficits in the planning and programming of movement gestures for speech production
- Often occurs along with language and phonologic impairment
- Some of the main speech characteristics
 - Vowel and consonant distortions
 - Inconsistent voicing errors
 - Prosodic errors, especially equal stress and segmentation
 - Awkward and/or imprecise movement transitions
 - Groping and/or trial and error behavior

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Here are some brief clips of children with CAS to paint a brief picture of children with this type of Speech Sound Disorder (SSD)

Praxis Deficits

- Deficits in the ability to conceptualize, plan and program skilled volitional movement
- Likely caused by caused by some determined (acquired) or undetermined (developmental) problem in cortex.

Execution Deficits

- Usually caused by some impairment in the central or peripheral nervous system.
- Often presents as weakness, with decreased range of motion, speed and force of movement

Caveat –
Weakness vs. tone

Muscle Tone

- State of partial contraction of muscle fibers at rest and in response to passive stretch
- It is maintained by a number of processes, with special influence by the cerebellum
 - ☐ Gamma loop
 - ☐ Stretch reflex
- The term “muscle tone” is often equated with reduced strength – but they are not the same thing

For Example

- A common statement in pediatric neurology reports:

“Generalized low tone, normal strength”

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What is Strength

- Strength is associated with muscle contraction causing movement of a structure
- In order to move a structure
 - Upper motor neurons (UMN) are “recruited” to communicate with lower motor neurons (LMN)
 - The LMN goes out to innervate muscle, causing contraction, and movement of the structure
 - Each LMN sends fibers that branch and wrap around a number of muscle fibers
 - Each muscle fiber may get input from several LMNs

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Strength

- LMNs that innervate muscles in structures that are responsible for fine skilled movement (like those for speech) have
- Strength increases when we overload the muscle in some way
 - increase in the size and number of muscle fibers (muscle mass)
 - Recruiting a greater number of motor units
 - Increases in the firing rate of motor units

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**Application to Clinical Practice –
Clinical Decision Making**

- Tone and strength are two different things
- If the child has generalized “low tone”, they may not actually be weak
- What kind of evidence could you look for that would help you feel confident they are not “weak”
 - Spontaneous plosives
 - No nasality
 - Good volume and respiratory support

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- If the child is actually weak (often due to some problem with the LMN)
 - Is CAS the appropriate diagnosis?
 - Is dysarthria an appropriate diagnosis?
- If the child has good respiratory support, no nasality, and can make plosive sounds without effort
 - Is CAS the appropriate diagnosis?
 - Is dysarthria the appropriate diagnosis?

Be thinking about these questions as we go along

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What do we mean by Motor Planning/Programming

- Today we are discussing a type of Speech Sound Disorder – CAS
 - CAS has been attributed to difficulty with aspects of the motor planning/programming processes involved in speech
 - So what is actually involved in the act of speaking?
 - Respiratory support
 - Sound source
 - Resonance of that sound source
 - Constriction of the air stream
 - How does planning/programming fit into this?**

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➤ Speech sounds are produced because of specific sequences of movement that are not discrete but blend from one gesture to another.

□ Speech production involves a continuous movement of parts of the vocal tract at the level of the syllable. There is no stopping of the movement during the syllable

□ The motor planning areas of the brain use a constant stream of information about where the speech structures are in space, whether or not they are moving, in what direction, with how much force and muscle tension—which is then used to program ongoing volitional or purposeful movement for continuous speech.

➤ As a speaker gets ready to talk, particular muscle groups are selected to:

□ Begin to contract at very specific times to cause structures to begin to move at a certain time, in a particular direction, at a certain speed, with a certain amount of force, using a specified amount of muscle tension

□ These can be called “Parameters of movement”

- Range of motion
- Direction of movement
- Speed
- Force
- Amount of muscle tension

➤ These parameters of movement are “specified”

➤ Particular muscle groups begin to contract at just the right time

➤ This allows the articulators to reach a particular temporal/spatial target (reaching just the right place, in just the correct manner, at just the right time) for the intended syllable or string of syllables.

➤ In children who have significant difficulty with praxis for speech (CAS):

- ❑ It may be the primary difficulty is with the specification of movement parameters required to make articulatory gestures for the correct and continuous spatial/temporal targets due to difficulty with
 - The afferent proprioceptive information
 - Motor planning areas of cortex
- ❑ Therefore, it is important to think in terms of assessing (and treating) movement gestures or transitions rather than phonemes when interpreting assessment data and coming to a differential diagnosis

➤ A child may difficulty with praxis:

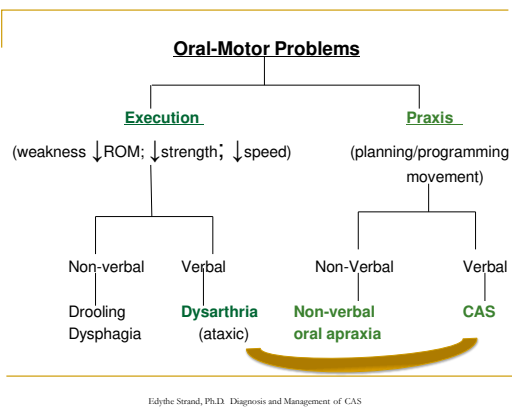
- ❑ For speech production, for which we use the term "childhood apraxia of speech" (CAS)
- ❑ Or for non speech volitional movement (kiss; cough; lip smack) for which we use the term "oral non-verbal apraxia"

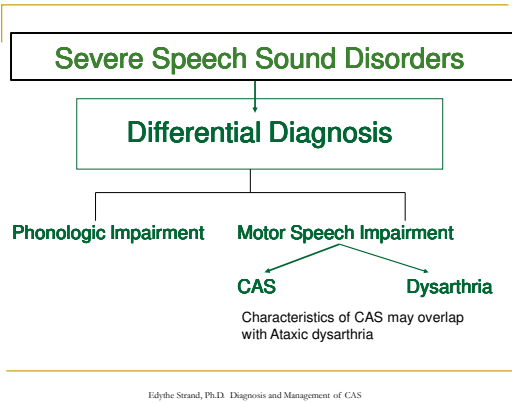
➤ If a child has nonverbal oral motor problems because of actual weakness or paralysis, they will also have associated problems in speech production, for which we use the term dysarthria

Caveat

➤ There is one type of dysarthria that is not associated with weakness – **ataxic dysarthria**

- ❑ this is characterized by impaired coordination in movement of the oral articulators
- ❑ It is associated primarily with deficits in the cerebellum
- ❑ Ataxic dysarthria and CAS can be difficult to differentiate in children (we will discuss this more later)





Caveat

- We've put a lot of emphasis on labels – on taxonomy. Maybe too much.
- These classifications are typically NOT discrete – they often co-occur, overlap and influence each other
- However, they are helpful in that they may differentiate factors that guide our treatment choices

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- They must be considered in terms of the child's developmental trajectory
 - ❑ As development (and therapy) proceeds, the characteristics of the disorder change, and **therefore the label may change**
 - ❑ Certainly what we do in treatment will change

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Differential Diagnosis

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So how might we recognize CAS

- Consider medical history, developmental history, issues related to speech and language development
- Make observations
 - ❑ Behavioral (speech + non-speech) characteristics
 - ❑ Compare those characteristics with those commonly accepted as being associated with the label "CAS"

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So how might we recognize CAS

- Testing
 - ❑ Typical language and cognitive assessments and observations
 - ❑ Motor speech examination
 - ❑ Dynamic motor speech evaluation
- Testing will not always be
 - ❑ Standardized
 - ❑ normative

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Example of an Apraxia of Speech Protocol - Children

- Language sample
 - ❑ Free play
 - ❑ Structured play
 - Test of Articulation or phonology
 - Structural/Function Examination
 - **Motor Speech Examination**
- Make observations regarding phonemic and phonetic inventories; AOS characteristics
 - Examine phonologic skill
 - Determine or r/o dysarthria & non-verbal oral apraxia
 - Make further judgments regarding the presence and severity of CAS markers

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Often present but not discriminative
Children with delayed speech development or phonologic impairment may also exhibit these characteristics

- | | |
|---|---|
| <ul style="list-style-type: none">➤ Limited consonant and vowel repertoire➤ Use of simple syllable shapes➤ Frequent omission of sounds➤ Numerous errors – poor Standard Scores on articulation test➤ Poor Intelligibility | <ul style="list-style-type: none">➤ Children with all types of SSD may make numerous errors➤ Children with phonologic impairment may make more substitution errors➤ Any child with a severe SSD (CAS, phonologic impairment and/or dysarthria) may show poor intelligibility |
|---|---|

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Characteristics more likely to be discriminative
Children with CAS frequently exhibit these characteristics which are seen less often in children with other SSD

- Difficulty moving from one articulatory configuration to another
 - Groping and/or trial and error behavior
 - Presence of vowel distortions
- Movements may be awkward or clumsy as the child attempts the continuous movement across the syllable.
 - Typically seen in elicited versus spontaneous utterances
 - These are not substitution errors, but are distortions of the intended vowel.

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Characteristics more likely to be discriminative

- Prosodic errors
 - Inconsistent voicing errors
- Lexical stress errors; equal stress; segmentation
 - May hear a voicing error where it is hard to distinguish if it is voiced or unvoiced (likely due to mistiming of VOT)

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Video examples of children with CAS at different levels of severity

From Mayo Clinic Video

Segment 3: Examples of different levels of CAS severity

<https://www.youtube.com/watch?v=cEOy3APLA-g>

Full video with all segments

https://www.youtube.com/watch?v=x15nL_MicOw

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What About Ataxic Dysarthria

- Ataxic dysarthria is typically caused by damage to the cerebellum
- Cerebellar function
 - ☐ Help maintain muscle tone
 - ☐ Coordination and balance
- Speech Characteristics of Ataxic Dysarthria
 - ☐ Inaccurate movements
 - ☐ Inconsistent Voicing errors
 - ☐ Imprecise articulatory contacts
 - ☐ Incoordination of the respiratory stream

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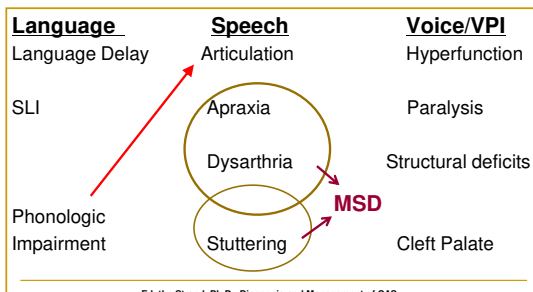
Differentiating Ataxic Dysarthria and CAS

CAS	Ataxic Dysarthria
Inconsistent errors	More consistent across tasks and in connected speech
DDK – Will repeat a series of one syllable better than a series of 3 different syllables (pa pa pa versus pa ta ka)	DDK - Will have discoordination in all 3 syllable types (pa pa pa; pa ta pa ta; pa ta ka)
May have gross motor problems (global apraxia) but not ataxic gait	May have ataxic gait, intention tremor and other signs of general ataxia

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Distinguishing CAS from other Types of Speech Sound Disorders

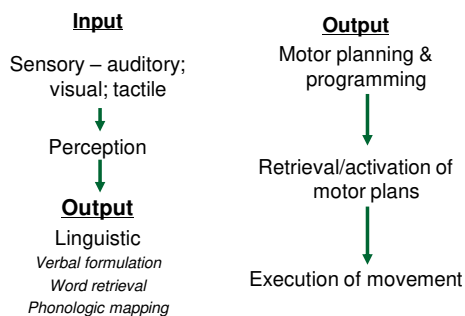


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- There are a number of different terms used to denote subtypes of SSD: examples include
 - ☐ Phonologic impairment
 - ☐ Inconsistent speech disorder
 - ☐ Articulation delay or disorder or residual articulation impairment
 - ☐ Motor speech disorders
 - Childhood Apraxia of Speech (CAS)
 - Dysarthria

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Very Basic Model of Speech Processing



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It's helpful to consider a simple model of speech production to explain to parents

Ideation	Communicative Intent	(Cognitive)
Language	Word retrieval Phonological mapping Syntactic/grammatical ordering	(Linguistic)
Motor Planning	Specify Movement Parameters	
Motor Programming	Range of motion Strength Speed Direction Degree of muscle contraction	(Motor - Praxis)
Acoustic Output	Execution of Movement	(Motor - Execution)

Example of an Apraxia of Speech Protocol - Children

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Motor Speech Exam (MSE)

- Allows the clinician to observe speech production across utterances that vary systematically in length and phonetic complexity
- Allows observations of those behaviors frequently associated with deficits in speech praxis (e.g. distortions, timing errors, dysprosody, inconsistency, etc.) **ACROSS** hierarchically organized stimuli
- However – I want to make the argument that we need to use dynamic assessment in MSEs

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Dynamic Assessment-

- Dynamic assessment involves a process in which cueing is provided to facilitate performance and thereby reveal emerging skills.
- It contrasts with static assessment, typical of most standardized tests, in which the child's well-established skills are measured after a single response with no assistance from the examiner (Lidz & Peña, 1996).

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Dynamic Motor Speech Exam: Rationale

- A dynamic motor speech exam offers particular advantages in the differentiation of motor speech impairment in children with severe speech sound disorders
- Incorporation of dynamic assessment as part of motor speech skill testing would allow observation of what the child does when he or she attempts movement gestures for specific syllable shapes (versus what he or she does habitually, as in a spontaneous speech sample).

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- ❑ For example, when the child is attempting to imitate specific movement gestures with cueing, we may see behaviors absent in spontaneous speech
- ❑ Without cueing, the child may not increase attention or effort toward a particular spatial or temporal target. With even minimal cueing (e.g., “watch me”, or a gestural cue), it is common in our experience for the child to more actively attempt the correct movement gesture.

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- In the case of differentiating children with CAS, we have the opportunity to evaluate those characteristics associated with that label. For example, we may see
 - ❑ groping that is not evident in spontaneous speech, but occurs when trying to imitate specific movement gestures with cueing
 - ❑ inconsistency across trials as cueing occurs
 - ❑ segmentation of syllables which occurs only when attempting the correct articulatory movement gestures or when given unfamiliar bi or multisyllabic words

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Dynamic Motor Speech Exam: Rationale

- Besides providing insights into the nature of the child's problem, the cueing used in dynamic assessment has the potential to facilitate judgments of severity and therefore prognosis
- Judgments of severity and prognosis are supported because if a child consistently needs considerable cueing to correctly produce a target or never produces it correctly despite cueing, his problem is seen as more severe, making the prognosis for rapid improvement more guarded

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Dynamic Motor Speech Exam: Rationale

- ❑ Severity of the impairment in children impacts how principles of motor learning are applied to clinical decision making in treatment planning.
 - For example, for children with more severe speech praxis difficulties, the clinician would devise a smaller stimulus set
 - Frequency and type of feedback is also influenced by the age of the patient and the severity of the impairment

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Dynamic Motor Speech Exam: Rationale

- Treatment planning should also be facilitated through dynamic assessment in a number of ways
 - ❑ The types of cues that proved helpful during the administration of the test suggest cueing strategies that are likely to be useful in ongoing treatment.
 - ❑ Reviewing errors on specific vowels and across particular syllable shapes facilitates choices of early stimulus sets.

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So – let’s consider a motor speech examination in the context of Dynamic Assessment

Dynamic Evaluation of Motor Speech Skill (DEMSS)

(Strand, McCauley, Weigand, Stockel & Baas, 2013)

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The DEMSS

➤ Motivation for the DEMSS

- ❑ Need for something more structured for the very severe children
- ❑ Needed a MSE designed to elicit attempts at imitation for a simple hierarchy of utterances, allowing clinicians to judge variables most consistent with current views of characteristics associated with deficits in praxis

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The DEMSS examines four parameters frequently associated with diagnosis of CAS

➤ Parameter

- ❑ Movement accuracy
 - ❑ Vowel Errors
 - ❑ Consistency
 - ❑ Prosody
- Practice in listening and judging vowel distortions and prosodic errors is provided in the advanced workshop***

- The test uses a multidimensional scoring system to examine responses to levels of cueing in order to determine prognosis

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You don't have to use the DEMSS

- You can devise a dynamic motor speech exam for a particular child
 - ☐ Choose your hierarchy of syllable shapes as well as consonants and vowels to sample across co-articulatory context
 - ☐ Have the child repeat the utterance
 - ☐ Provide cueing as necessary to elicit improvement in production

Videos of, and practice in doing dynamic assessment is provided in the advanced workshop

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Scoring Examples

- Binary – right/wrong
- Multidimensional: (e.g.)
 - ☐ 2 = correct
 - ☐ 1 = close (mild vowel distortion; one distinctive feature off error)
 - ☐ 0 = incorrect
- Notes or Tallies
 - ☐ Voicing errors
 - ☐ Inconsistency
 - ☐ Vowel distortions

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Additional Evidence for the Presence of CAS – note the presence of any of these across all assessment tasks

- Difficulty achieving articulatory configurations or inaccurate movement gestures (transitions)
- Inconsistent Voicing Errors
- Groping
- Intrusive Schwa
- Slow Rate
- Trial and Error Behavior
- Distorted substitutions
- Equal stress or lexical stress errors
- Segmentation
- Increased difficulty with multisyllabic words

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➤ These observations have been used in several studies examining potential markers for CAS.

(Shriberg, Potter & Strand, JSRR, 2011; Shriberg, Lohmeier, Strand & Jakielski, Clinical Ling. & Phon., 2012)

- ❑ If the child exhibits 4 or more of the 10 characteristics, seen in 3 or more of the assessment tasks, CAS was considered present
- ❑ Keep in mind, however, if a child also has dysarthria, slow rate, and some distortions may be due to the dysarthria, not CAS.

From Assessment to Treatment

➤ We use our interpretation of assessment results to:

- ❑ Come to our differential diagnosis
- ❑ Write diagnostic statements
- ❑ Make initial recommendations
- ❑ Determine initial therapy goals

- ❑ Make initial clinical decisions regarding
 - Approach and Method
 - Initial stimulus set
- ❑ Use the principles of motor learning to determine
 - How we will organize practice
 - How we will provide type and amount of feedback
 - Cueing strategies

The differential diagnosis

- After coming to a diagnosis, the clinician is charged with communicating that in a written report
- These statements of diagnosis are important and should reflect the **clinical thinking** that went into them, illustrate the overlapping nature of presenting deficits, and include some statement of severity and prognosis
- You will get practice in writing diagnostic statements in the advanced workshop, but here is an example

Practice in writing diagnostic statements is practice in clinical thinking!

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Diagnostic Statement

- a 5-year-old male who is exhibiting low average receptive language skills, severe impairment in expressive language, and a severe impairment in speech acquisition, due primarily to difficulty with planning and programming movement gestures for speech production (CAS). There is no frank evidence for dysarthria. He is pragmatically and socially appropriate, focuses attention well, and attempts all tasks.

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Diagnostic Statement Example

This child exhibits a moderate phonologic impairment characterized by fronting, and consistent typical substitution errors for later developing sounds. In addition, he exhibits a slightly slower rate, more difficulty with multisyllabic words with occasional segmentation and occasional vowel distortions providing evidence for a mild contribution of difficulty with praxis for speech (mild CAS). There is no evidence for dysarthria. There is no evidence for receptive or expressive language delay or cognitive impairment.

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TREATMENT OF CAS

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Engaging the Child in Motor Based Learning What has to Happen?

- The motor learning literature notes that the child needs to have the intent to improve movement
- Help the child understand that we will be working on “moving our lips, jaw and tongue” so that it will be easier to talk

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Facilitate the Child's awareness of the intent to improve movement

- Non-speech oral motor activities might be appropriate to begin the session
 - ❑ The clinician may have the child move the jaw, lips, and tongue while the therapist encourages the child to feel the movement
 - ❑ The clinician may even describe the movement as they are doing it
 - ❑ However, these warm-up drills should be focused specifically toward improving the child's attention and effort toward the movement and are not necessarily facilitative to improvement in speech production.

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➤ There are some children who are not yet ready for direct treatment – what can we do?

- ❑ Help the child develop the ability to volitionally vary parameters of movement; big-little; fast-slow; tight-loose) – e.g.
 - Move the jaw open wide – then small
 - Move the jaw fast – then slow
 - Move the tongue out far – then little
- ❑ Work to develop better eye contact
- ❑ Work to decrease tactile defensiveness

➤ Parents can be very helpful here

Later, when we are talking more specifically about treatment-- we'll emphasize

- ❑ Practice should focus on making movement transitions, in the context of speech
- ❑ At first, the clinician will provide maximum support by providing visual, tactile and auditory models, fading those cues over time
- ❑ Because the goal of treatment is to improve movement accuracy, it is important to implement the principles of motor learning

Principles of Motor Learning

Coming to Decisions regarding the Implementation of a Method (treatment)– Using PML

- The Principles of Motor Learning need to be implemented to the degree you are focusing treatment on motor learning
 - ❑ If CAS is severe, most will be implemented in a way that addresses the severity – then faded as the child improves
 - ❑ If the contribution of CAS is moderate to mild, PML will be implemented to the degree necessary

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Principles of Motor learning (PML)

- PML come from the cognitive motor literature and most of the data has come from limb movements – especially simple movements

- Over the last 10-15 years they have been increasingly incorporated into treatment for motor speech disorders

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- While some studies have shown that the PML can also apply to speech movement – others have not.
- Have to take into account:
 - ❑ Speech is a complex movement
 - ❑ Language is interactive

- Severity plays a large role in how one implements PML in treating children with CAS

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What is Motor Learning

- A process of acquiring the capability for producing skilled action
- It occurs as a result of experience and practice
- It is influenced by a variety of factors.
- These factors make a difference in therapy

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Principles of Motor Learning

I'll be discussing:

- Precursors to Motor Learning
- Conditions of Practice
 - ❑ Repetitive motor practice
 - ❑ mass vs. distributed practice
 - ❑ Variability of practice
 - ❑ Feedback
 - ❑ Influence of rate

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Principles of Motor Learning

Precursors to Motor Learning

- ❑ Motivation
- ❑ Focused attention
- ❑ Pre practice

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Conditions of Practice

Practice

- ❑ “In order to learn motor skill, one must practice the movement”

- ❑ Need enough trials per session to allow motor learning to occur and become habituated

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➤ Treatment planning - must build this in

- ❑ Use activities that keep the child’s face looking at the clinician
- ❑ Use reinforcements that do not take time
- ❑ Use activities that facilitate repeated opportunities for practice

➤ Quality of practice (focused attention; scheduling feedback)

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Practice can Lead to Different Outcomes

- **Motor Performance** – the movement skill shown during the session, with cueing

- **Motor Learning** – the ability to use that motor skill in another context, at another time, over time (generalization).

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Conditions of Practice

➤ Mass vs. Distributed Practice

- Frequency of Sessions
- Stimulus Set size

➤ Random vs. Blocked Practice

- How practice is scheduled
- Practice each stimuli in a block
- Practice each stimuli once or twice, randomly across the whole set

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Decisions depend on:

➤ severity and type of the speech disorder

➤ immediate goal:

- mass yields quick development of the skill, but poor generalization for incorporating in into other motor skill*
- distributed takes longer, but get better motor learning*

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Schedules of Practice

Blocked practice - leads to better motor performance - but not necessarily motor learning

Random practice - better motor learning – but it may take too long for the child to achieve initial success

- if CAS is quite severe, start with more blocked practice, moving to more random practice
- Always have some distributed practice
 - If very severe – start with only 5-7 utterance
 - Gradually increase set size as improvement occurs

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Variability of Practice

- Have the child practice movement sequences in different contexts and conditions to facilitate motor learning.
- First, in choosing stimuli, one may want to have a particular movement sequence (e.g., the movement from lip closure to a vowel) represented in several stimuli, but with different coarticulatory contexts and different manners of production.

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- For example, the set may include “me, my, boo, baby” along with other stimuli.
 - After the movement sequence is produced accurately in one prosodic context, the clinician will want to model the utterance with varied prosody and loudness to practice more flexibility in motor planning and programming.

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Feedback – Knowledge of Results

Feedback

- Intrinsic - sensory information – what the child hears and feels and sees
- Extrinsic - generated outside the learner
 - ☐ Knowledge of Results – outcome accuracy
 - ☐ Knowledge of Performance – movement outcome (specific information about the performance)

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Feedback – Knowledge of Results

- Intrinsic - sensory information (what the child perceives from hearing and feeling)

- Extrinsic – What we provide
 - ☐ Knowledge of results – outcome accuracy
 - That was right!
 - Very good!
 - ☐ Knowledge of Performance
 - Not quite – close your mouth a bit
 - Uh-oh – not so tight!

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Feedback

- Knowledge of Results - right/wrong

- Knowledge of Performance - what happened; what should the child do differently

Extrinsic feedback is most important to learning in those cases where available sensory feedback may be inadequate – as in CAS.

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Feedback

- Extrinsic feedback -
 - ☐ more important early and with more severe impairment
 - ☐ later in treatment, give less extrinsic feedback (as too much reliance on extrinsic may lead to decreased motor learning)

- Amount and precision of feedback should be great at first, then decreased as magnitude of errors decreases (to facilitate motor learning)

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Timing and Frequency of Feedback

- Immediate - use early in treatment and when impairment is severe as this improves motor performance

- As the child improves, use less immediate and less frequent to facilitate motor learning

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Additional General Comments on Treating the Praxis Impairment in CAS and Facilitating Motor Learning

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Frequency of practice

- Schedule shorter frequent sessions
 - ❑ E.g. 5 times a week on an individual basis for 20-30 minutes of continual practice
 - ❑ maximize the number of practice trials per session
 - use of reinforcers that take very little time
 - novel ways to keep their interest without taking them away from the task
 - Use reinforcers that keep the child's attention to the clinician's face

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Modifying the use of rate

- Produce the movements for the utterance very slowly at first (perhaps even in unison with the therapist) and then gradually increasing rate with continued practice trials until they are producing the movement accurately, at normal rate, and with normal prosody.
- Have the child stay in the initial articulatory configuration for a second or two before actually starting the movement gesture
- The use of slower rate and staying in the initial configuration helps maximize proprioception

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Feedback

- Knowledge of results versus performance.
 - ❑ At first, feedback should be frequent and focused on performance as well as outcome
 - ❑ Help the child know what was wrong about the movement rather than just whether their production was right or wrong (e.g., make your tongue a little tighter; close your jaw a little bit)
 - ❑ As the child becomes more accurate with the movement, feedback should become more random in order to improve motor learning (generalization)

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Maintain coarticulation in movement

- Children with apraxia of speech need to maintain coarticulation between as well as within syllables
- It is important to avoid pausing in voicing or movement gestures within syllables so that the child has the opportunity to practice the complete movement gestures in the correct coarticulatory context.

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- ❑ For example, separating the phonemes in the word "boy" to /b...oy/, and then having them try to blend movement gestures is very difficult for children with apraxia of speech
- ❑ While this is often an appropriate technique for some children with phonologic impairment, it actually increases the difficulty for children who have difficulty with planning movement gestures and should not be included as a strategy in therapy for children with apraxia of speech

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Prosody

- It is very important for children with apraxia of speech to begin to work on prosody very early
- As the child becomes more accurate, the therapist is able to gradually increase rate toward normal, with repeated practice trials.
- It is also important to work on establishing correct lexical as well as phrasal stress early in treatment
- Varying the prosody is also important early on in therapy, to help the child establish some flexibility in their motor planning and programming.

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Treatment Planning And Implementation of Treatment Techniques

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How do We Start Treatment Planning?

- Use your assessment data and decisions about the relative contribution of linguistic/motor impairments to come to a differential diagnosis
 - This will guide you in all treatment planning and doing
 - It will guide you in goal writing
 - This differential diagnosis may change over time – your treatment plan and implementation will also change

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In CAS the goal or the focus of treatment is to improve the individual's ability to assemble, retrieve, and execute motor plans for speech

The focus or target of treatment is the movement – versus the sound

And that changes EVERYTHING

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- The words we use
- Choice of approach
- Choice of method
- Choice of techniques
- Choices in types of cueing
- Organization of practice during the session
- Types and amounts of feedback

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When the focus of treatment is on the movement (vs. the phoneme)

The child must be offered the opportunity to practice the movement

➤ At first maximum cues are provided, and then they are faded, giving the speaker increasing responsibility to formulate and execute the plan on his or her own.

*** caveat: since language (including phonologic impairment) is typically also present, one needs to also take those deficits into account*

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➤ General principles of treatment include focus on movement performance drill, movement patterns, and sequences of movement.

➤ Intensive, frequent, and systematic practice toward habituation of the movement pattern is a salient part of all treatment programs designed to improve motor skills.

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- These approaches also include careful construction of:
- hierarchies of stimuli
 - the use of decreased rate with proprioceptive monitoring
 - pairing movement sequences with facilitators such as limb movement, intonation, and rhythm.

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It is important to keep the word *movement* in mind

This is Because:

- Students and clinicians are accustomed to thinking in terms of “sound errors” and treating “sound” production

- Because speech consists of meaningful sound combinations, sound production has to be the ultimate goal in apraxia of speech treatment

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How does one focus treatment on *movement*?

- If the nature of the movement impairment is one of weakness due to spasticity or flaccidity, such as might occur in dysarthria, movement is treated by improving physiologic support.
- The movement disorder in apraxia, however, is characterized by difficulty achieving articulatory configurations and transitioning into and out of these configurations.

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Therefore

- Practice should focus on making those movement transitions, in the context of speech
- At first, the clinician will provide maximum support by providing visual, tactile and auditory models, fading those cues over time
- Because the goal of treatment is to improve movement accuracy, it is important to implement the principles of motor learning

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Goal Writing

- Many of you who work in the public schools are well practiced at writing IEPs, which emphasize measurable behavioral objectives
- I want to argue that the goal (whether written in your IEP or not) should also reflect your clinical thinking about what it is you're actually trying to change.

An example of a written goal for one specific case

- Case # 1
 - ❑ 5:4; hypoxia at birth; no current feeding problems
 - ❑ Frequent otitis media
 - ❑ Mildly delayed in meeting developmental milestones
 - ❑ Receptive language – low average
 - ❑ Expressive language – low (many signs – no speech)
 - ❑ MLU – 1; phonemes /m/ /n/ /p/ neutral vowel;
 - ❑ Word: ma; me (inconsistent)

- Normal structural – functional exam, with good respiratory support and normal phonation
- Significant oral-non-verbal apraxia
- MSE – numerous characteristics of CAS; needs many tries and much cueing but benefits from that cueing

Diagnostic Statement

➤ a 5-year-old male who is exhibiting low average receptive language skills, severe impairment in expressive language, and a severe impairment in speech acquisition, due primarily to difficulty with planning and programming movement gestures for speech production (CAS). There is no frank evidence for dysarthria. He is pragmatically and socially appropriate, focuses attention well, and attempts all tasks.

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Initial Goal

1. Improve his ability to make accurate movement gestures for production of /a/, /o/ and /u/ in a number of co-articulatory contexts, beginning with /m/, /n/, /b/ and /h/ at 100% accuracy in direct imitation; and at 80% accuracy in spontaneous production, within 4 weeks; using the initial stimuli: hi; bye; no; mom; knee, home and “nigh nigh”

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During the advanced course we will have additional practice in writing diagnostic statements and goals for children of different ages and different levels of severity

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Speech Sound Disorders -Treatment

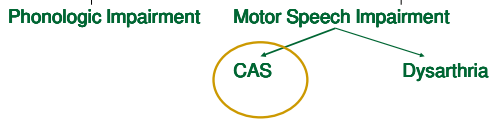
- There are a whole range of treatment strategies for children who exhibit speech sound disorders
- A number of these intervention strategies are designed specifically for children with motor speech impairment

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Severe Speech Sound Disorders

Differential Diagnosis



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What's involved in Treatment

Explaining the disorder to parents

Planning the therapy - **clinical decisions**

Implementing therapy – **clinical decisions**

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Educating Parents

- This is an important and imperative first step in treatment
- Clinical example:
 - I evaluated a young boy who had a severe SSD. He had been given the diagnosis of CAS in his home community. They were anxious about what that meant – and believed it was a medical problem, even asking me if he would need surgery.

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- They were very distraught and it was difficult for them to even listen to my explanation after I confirmed the diagnosis
- I listened a long while to their concerns and questions – then was able to start a discussion about the nature of the problem and what we could do about it.

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What we discussed:

- ◆ CAS is just a label for a subset of children with speech sound disorders
- ◆ I explained the difference between a medical diagnosis and a speech diagnosis
- ◆ I talked about the nature of CAS and explained that there are specific techniques which work
- ◆ Most importantly, I explained that most children with CAS will be verbal communicators

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- I then went over my initial goals, explaining my rationale for them
- I explained my choice of approach, method and initial stimuli – and why I made those decisions
- I talked with them about what they can do to help and that I would be guiding them in this along the way

The Advanced on-site workshop provides practice in explaining CAS to parents

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How do we use clinical thinking as we start treatment planning ?

What decisions do you typically make as you work on an initial treatment plan

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Let's go through a number of clinical decisions that we need to consider

- Approach (motor? Linguistic?)
- Specific Method – associated techniques and cueing
- Frequency of Treatment and length of sessions

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➤ Initial stimuli

➤ How will practice be organized within the session?

➤ Feedback – when; what type; how much?

Each of these decisions will be easier by incorporating PML for those children who have praxis deficits

Decide on an Approach

➤ This means coming to a decision about the relative contribution of motoric versus linguistic deficits needing to be addressed

- ❑ If the child's deficit in praxis for speech is severe – or the major contributing factor to his communicative disorder, then an approach focused on improving motor skill and motor learning should be emphasized
- ❑ As linguistic deficits are typically also involved, methods for improving language skills may be introduced as appropriate

Decide on a Method – (Treatment)

➤ There are many different published “treatments” for CAS (we will discuss these in a bit)

- ❑ Not all will be best for all children
- ❑ Choose based on severity, age, and associated deficits
- ❑ Your choice of method or treatment will likely change over time as the child's speech changes'
- ❑ You may decide to use a “combination” of treatments

Frequency and length of sessions

- Shorter more frequent sessions will be more effective and efficient for children with CAS – especially if more severe
 - ❑ The real world often makes this a challenge – but think outside the box!
 - ❑ May combine shorter periods of speech work in between periods of language work throughout a longer (one hour) session

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Initial Stimuli

- How many?
- Length and phonetic content?
- Syllable shape – vowel content?
- Real vs. non-sense words?
- How to elicit them?
 - ❑ Pictures?
 - ❑ Repetition?

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Choice of Initial Stimuli

- There are a number of decisions clinicians need to make when devising the initial stimulus set that are directly related to this idea of targeting movement gestures – especially important to vowels
- Choose initial stimuli based on vowel errors noted in the motor speech exam as well as syllable shape
- If severe CAS, be careful to restrict to only two new vowels (distorted vowels) across a couple of co-articulatory contexts

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Early Stimuli

- Begin with the child's current phonemic repertoire – consider the syllables shapes they already use
 - ❑ Using your vowel targets, add phonemes to create functional targets (words)
 - ❑ At first use phonemes already in their repertoire, introducing only one or perhaps two new ones to maximize functionality
 - ❑ If the child is severe, it may help to choose targets that have the same first and last phoneme; or phonemes that utilize the same place distinctive feature.

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Early Stimuli

- Remember to use severity as a guide to the number of stimuli
 - ❑ The more severe the CAS, the smaller the set size – but probably never less than 5 in order to maintain at least some distributed practice
 - ❑ When each target meets criteria for going out of training, then a new target is brought into the list
 - ❑ As the child improves motor skill, targets will begin to meet criteria more quickly – at that point, when one goes out to generalization – 2 new ones may be brought in, to gradually increase the set size

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Examples – (these will vary considerably from child to child- your rationale is important)

- | ➤ <u>Very Severe</u> | ➤ <u>Severe</u> | <u>Mod-Severe</u> |
|----------------------|-----------------|-------------------|
| ❑ No | ❑ <u>eat</u> | <u>my bed</u> |
| ❑ Hi | ❑ <u>No way</u> | I want to eat |
| ❑ Bye | ❑ <u>Hi</u> | <u>me too</u> |
| ❑ Mom | ❑ <u>Bye</u> | <u>movie</u> |
| ❑ Mo ("more") | ❑ <u>Hi Mom</u> | go <u>outside</u> |
| | ❑ <u>Mine</u> | <u>book</u> |

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Practice in choosing initial stimuli for children with varying degrees of severity of CAS will be done in the advanced on-site workshop

How Will Practice be Organized?

- | | |
|---|--|
| <ul style="list-style-type: none">• Blocked – each target practiced in blocks, once each session• Modified block – each target practiced in varying lengths of blocks, with blocks repeated 1, 2 or 3 times in the session• Random practice – each target practiced once, randomly throughout the session | <ul style="list-style-type: none">➤ Rarely if ever do this – need more distributed practice➤ Works well for younger children and those with more severe CAS➤ As each target becomes accurate, natural and can be produced in answer to a question, move to random throughout the session |
|---|--|

➤ Practice in clinical thinking for how to organize practice at different points in time during a child's course of therapy will be done in the advanced on-site course

Types and frequency of feedback

- Specific – early and when severe
- Fade to feedback about results only
- Fade to less frequent and with some delay

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Treatment Methods and Techniques for CAS

- **There is no single management procedure or program that is most appropriate for CAS**
- There are a number of principles in the literature that are typically accepted as being important.

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- Treatment methods for CAS fall into 4 general categories:

- Articulatory
- Tactile/gestural
- Prosodic
- Augmentative devices to facilitate communication

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Examples of Treatment Strategies

Remember: Most treatment involves a combination of those three perspectives

The important thing is.....

**INCORPORATE THE PRINCIPLES OF
MOTOR LEARNING**

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Articulatory

➤ Integral Stimulation

- Listen to me – watch me – do what I do
- Direct imitation emphasizing both the auditory and visual model is extremely facilitative to children with CAS.
- Having the child watch the clinician's face is a powerful cueing strategy.
- For young children or children with attention deficits this can pose a challenge.

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- Sometimes, we begin the therapy process by working in the session and having the parents work at home to establish good visual attention to a person's face, as well as general imitation skills

- These are prerequisites for the integral stimulation approach, and for most children can be achieved with a positive reinforcement behavior modification approach.

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Dynamic Temporal and Tactile Cueing (DTTC) (1 type of integral stimulation)

- DTTC was designed and is most appropriate for **severe** CAS

- Prerequisites for use of DTTC
 - ❑ Able to focus attention to the clinician's face for at least a few minutes at a time
 - ❑ Able to at least attempt direct imitation

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-
- **Best Candidates** for DTTC
 - ❑ Severe speech deficit due to CAS
 - ❑ Able to focus attention to the clinician's face at least for a few minutes at a time
 - ❑ Able to attempt direct imitation
 - ❑ Good parent support and participation
 - DTTC is not appropriate if the child
 - ❑ Does not have joint attention, or initiates attempts at communication
 - ❑ Cognitive level is too low to volitionally try the movements for the utterances

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DTTC

- DTTC is an articulatory treatment method based on integral stimulation.

- This treatment emphasizes the shaping of movement gestures for speech production and the continued practice of those gestures, in the context of speech.

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Remember - Changing the focus of treatment to movement vs. the phoneme – changes everything!

- How we choose stimuli for practice
- How we organize that practice
- We use the principles of motor learning to facilitate many of our clinical decisions

These clinical decisions – as we implement DTTC - greatly influences the efficacy and efficiency of therapy

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Dynamic Temporal and Tactile Cueing (DTTC)

- Integral to the method is the use of a specific hierarchy of temporal delay
- Allows opportunity for the child to take increasing responsibility for assembling, retrieving and executing motor plans with progressively less cueing

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- The **rationale** for this method comes from an important assumption regarding the nature of the impairment in CAS – that the primary deficit is that of motor planning and programming movement for volitional speech production.

- That leads to the conclusion that the focus of treatment is not on sounds – but on the movement gesture, or movement transitions that create the acoustic signal for sound combinations.

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➤ This is a paradigmatic shift from our typical goal of improving speech sound production

- ❑ If the focus of treatment is the movement, then that changes a great deal of what we do with respect to stimuli selection, verbal cues given to the child, etc.
- ❑ Being clear about the goal of intervention is essential in devising a treatment approach

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➤ When designing DTTC, a treatment focused on reducing the impairment in childhood apraxia of speech, the following rationale were considered.

- ❑ In apraxia of speech, the goal or the focus of treatment is to improve the individual's ability to assemble, retrieve, and execute motor plans for speech.
- ❑ In order to do that, the person must be offered the opportunity to practice these motor planning processes

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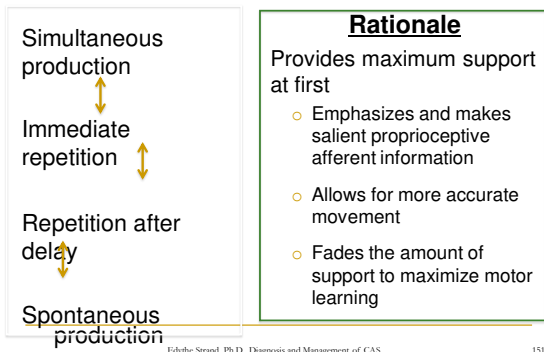
❑ At first maximum cues are provided, and then they are faded, giving the speaker increasing responsibility to formulate and execute the plan on his or her own

❑ When treating a motor speech disorder, one often needs to consider the complication of linguistic factors such as the acquisition of phonology and syntax.

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DTTC Procedures



Initial Procedure

- Therapist models utterance
- Child repeats
- If ok, then do it again,
- If not, go to simultaneous production

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- May have to augment simultaneous production with:
 - ☐ Tactile cues
 - ☐ Gestural cues
 - ☐ Phonetic placement
 - ☐ Holding the initial articulatory position longer

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- Therapist says the utterance while child watches the clinicians face - child attempts to repeat
- If the child is unsuccessful, move to **simultaneous** production
 - ❑ Therapist says the word along with the child
 - ❑ If the child still cannot get the initial articulatory placement
 - Use phonetic placement strategies
 - When the child achieves the spatial target, have them stay there for several seconds – then see if they can get back there

Another Strategy

- If the clinician feels the stimuli is appropriate, they may ask the child to just produce the movement for the target, without voice
 - ❑ This reduces the motor planning requirements by taking out the respiratory and laryngeal systems
 - ❑ Usually, children will be able to simultaneously produce just the movement gesture after a number of practice trials
 - ❑ Then, slowly build in a whisper and then go to voice

- Practice the word simultaneously
 - ❑ Use a slower rate -- adding tactile or gestural cues as necessary
 - ❑ Maintain both auditory and visual stimuli
 - ❑ Speak slowly, gradually moving toward natural rate
 - ❑ Give specific feedback at first, gradually moving to less specific and less frequent feedback

➤ When child achieves:

- ❑ No struggle or groping
- ❑ Good accuracy
- ❑ Normal rate
- ❑ Was able to vary prosody at least a bit

➤ Go back to direct imitation

- ❑ This is often a point where they will falter
- ❑ If so, add a mime while they attempt the utterance after your model
- ❑ Do this until they can easily imitate
- ❑ If this is not successful – go back to simultaneous

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DTTC Procedures

- Continue to proceed with adding and fading cues until the child can repeat the selected target
- As before, when the child is accurate, speaking at normal rate and with no struggle or hesitation, then begin to vary prosody and move to the next level, which is the delayed condition

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➤ Addition of delay

- ❑ Therapist says the target utterance
- ❑ Insert a delay (one to three seconds) before imitative response
- ❑ After the child is successful at repeating the utterance after a 2 or 3 second delay, have the child repeat the target several times without intervening stimuli
- ❑ As before, always add or fade cues as necessary until the child is accurate, with no hesitation and normal rate, and can vary prosody

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- Finally, work to elicit the utterance spontaneously with questions
 - ❑ Remember – at first we used blocked practice
 - ❑ At this point, the target is likely being practiced randomly and will be elicited sporadically throughout the session
 - ❑ You have also faded the frequency and specificity of feedback
- Keep in mind, the hierarchy of cueing is not linear or static
 - ❑ It is constantly changing as the therapist adds or fades cues depending on each of the child's responses.
 - ❑ Also, **different targets may be at different places in the cueing hierarchy**

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Treatment efficacy has been shown for DTTC

- ❑ Strand and Debertine (2000)
- ❑ Strand, Stoeckel, Baas, (2006)
- ❑ Baas, Strand and Stoeckel (2009)
- ❑ Maas, Butalla, and Farinella (2012)
- ❑ Maas, and Farinella (2012)

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VIDEO EXAMPLES OF DTTC

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Another Example of an Articulatory Approach based on Integral Stimulation

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ReST -- Rapid Syllable Transition

- Incorporates theories of motor control and learning and incorporates principles of motor learning
- Goal: maximize long-term maintenance and generalization of treated speech skills
- ReST involves intensive practice in producing multisyllabic pseudo-words (e.g. toobiger) to improve the accuracy of speech sounds,
 - ❑ Involves practice of transitioning rapidly and fluently from one sound/syllable to the next
 - ❑ Practice in the control of the melody in the form of relative emphasis, or stress, placed on each syllable within a word.

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-
- ReST involves two components within each treatment session
 - Pre-Practice (or training) Component where the stimuli are taught with cues to shape accurate production and immediate, specific feedback is given after each production
 - This is followed by a longer Practice Component incorporating those Principles of Motor Learning that have been shown to facilitate long-term learning and generalization of skill
 - Knowledge of results vs. performance
 - timing/fading of cues

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Efficacy Data for ReST

- Murray, E., McCabe, P., Ballard, K. (2012) A comparison of two treatments for childhood apraxia of speech: methods and treatment protocol for a parallel group randomized control trial. *BMC Pediatr.* 12: 112
- Murray, E., McCabe, P., Ballard, K. (2015) A Randomized Controlled Trial for Children With Childhood Apraxia of Speech Comparing Rapid Syllable Transition Treatment and the Nuffield Dyspraxia Programme—Third Edition. *Journal of Speech, Language, and Hearing Research*, Vol. 58, 669-686.

See this website for complete information on ReST
www.sydney.edu.au/health-sciences/rest

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Prosodic Methods

- Melodic Intonation Therapy (MIT) was originally proposed as a treatment method for acquired AOS it has also been proposed for use with children with CAS (Helfrich-Miller, 1994)
- In this adaptation for children, stimuli progress from simple two- to three-word phrases to more grammatically and phonetically complex utterances
- When the method is used for children, Helfrich-Miller (1994) suggests the use of symbols of signed English as the method of keeping time (in contrast to tapping out the rhythm, as is used for adults).

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Contrastive Stress

- Facilitates variability of practice
 - ☐ When utterances are accurate, practice them with different vocal inflection
 - ☐ Change rate or volume
- Facilitates phrasal and lexical stress
 - ☐ E.g. Bob hit the ball
 - Who hit the ball
 - Did Bob kick the ball?
 - Did Bob hit the truck?

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Additional Methods for Lexical and Phrasal Stress

- Gestures – arm and/or body movements
- Tracing the prosodic pattern
- Older children – writing the syllable structure for multisyllabic words
 - ☐ te le phone
 - ☐ Ad ven ture
 - ☐ Ka la ma zoo

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Tactile/Gestural Approaches

- Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT)
 - ☐ A method devised for use with children with childhood apraxia (Hayden & Square, 1994)
 - ☐ It is appropriate for CAS because it implements a motor approach to treatment, emphasizing movements into particular articulatory positions
 - ☐ The cues involve very specific placement of the fingers to cue place and manner of articulatory positions, and are provided serially in order to guide sequential events for syllables and words
 - ☐ Feedback is primarily tactile and kinesthetic.

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What is the Current Evidence?

Murray, E., McCabe, P., Ballard, K. (2014)

A Systematic Review of Treatment Outcomes for Children with Childhood Apraxia of Speech

- Searched peer-reviewed treatment articles from 1970 to 2012 at all levels of evidence:
 - ☐ Published communication outcomes for children with CAS.
 - ☐ Compared treatment and generalization evidence.

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Murray, E., McCabe, P., Ballard, K. (2014)

- They found Forty-two articles representing Phase I and II single-case experimental designs
 - ❑ 23 SCED (single case experimental design)
 - ❑ 19 case series or description studies
 - ❑ Found 13 approaches within the 23 SCED articles,
 - motor skills (n = 6)
 - linguistic skills (n = 5)
 - augmentative and alternative communication (n = 2).

Clinical Implications

- They concluded two motor treatments (DTTC and ReST) and one linguistic treatment (Integrated Phonological Awareness Intervention) are best suited to clinical use
 - ❑ sessions at least twice a week and dose above 60 trials per session.
 - ❑ DTTC appears to work well for clients with more severe CAS,
 - ❑ ReST appears to work well for children 7–10 years of age with mild-to-moderate CAS
 - ❑ Integrated Phonological Awareness Intervention appears to work better for children 4–7 years of age with mild to severe CAS and language impairment

CONCLUSIONS

- Treatment for CAS requires:
 - ❑ The clinician be well aware of the motor processing involved in speech production and the way in which those motor processes interact with language
 - ❑ Further, the clinician should be knowledgeable about the principles of motor learning and how application of those principles is integral to treatment planning

Treatment Pearls for Monday morning (for children with CAS)

- Increase # of responses per session
- Review your choice and number of stimuli
- Increase the child's motivation and ability to watch your movements
- Add and fade cues as needed

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A Few Do's and Don'ts for CAS Treatment

DO's

- Maximize responses per session
- Practice the movement gesture for the syllable as a whole – no interruption

Don't

- Use games and pictures that take their attention away from your face and decrease responses
- Don't separate syllables:
 - B - oy
 - U - p
 - M - e

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Most Important Points to Take Away!

1. CAS is a label for a type of speech sound disorder – not a medical diagnosis
1. The focus or target of treatment is the movement – versus the sound ---And that changes **EVERYTHING**
3. Create specific stimuli based on vowel content and syllable shape during early treatment and use fewer stimuli, with more dynamic "shaping" of the movement accuracy

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4. Maximize response trials per session

- 1. Rather than pictures or games, use quick reinforcers**
- 2. Maximize their ability to look at your face**

5. Incorporate PML (blocked to random practice and frequent + specific to less specific and infrequent feedback)

6. Use probe testing (vs. treatment data) to measure progress

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And for Sure

➤ **Make sure you have a rationale for each clinical decision you make**

➤ **Be confident in your ability to explain that decision to parents and others**

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