DYNAMIC TEMPORAL AND TACTILE CUEING (DTTC)

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DISCLOSURES

Non-financial

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Purpose and Scope

- Review the motivation and rationale for DTTC
- Describe the children for whom the method is appropriate
- Describe the DTTC hierarchy
- Discuss important decisions one makes when implementing DTTC and the principles of motor learning (PML) which motivated their use

There are two handouts; slides and additional references, including where to find video of DTTC

Learning Objectives

- The viewer will be able to describe the rationale for use of DTTC
- The view will be able to list and describe those for whom the method was developed
- The viewer will be able to demonstrate administration of the DTTC hierarchy
- The viewer will be able to describe how to implement PML when making clinical decisions in the administration of DTTC

Dynamic Temporal and Tactile Cueing (DTTC)

- Is a motor based treatment designed for childhood apraxia of speech (CAS) - especially severe CAS
- Its design and procedures, including important clinical decisions are based on principles of motor learning (PML) in order to facilitate acquisition and retention of skills
- The rationale for DTTC as well as the key elements important in administrating the method are supported by models of speech productions as well as theories of motor learning

- At first, DTTC was referred to as "Integral Stimulation Therapy" (Strand & Debertine; 2000 Strand & Skinder, 1999)
- As DTTC was refined and further tested for efficacy, I named the method Dynamic Temporal and Tactile Cueing to more clearly illustrate the nature of the method
- Central to the methodology is the use of a temporal hierarchy –
  - Varying the amount of time between the clinician's model and the child's response
  - This provides a way to incrementally help the child take increasing responsibility for the motor planning/programming processing

Choosing a Method for Treating CAS

- Many factors are important when choosing a specific method for treatment
  - the evidence for efficacy
  - age of the child
  - severity of the disorder
- It is important to choose a treatment approach to address the underlying area of impairment, - therefore we have to be confident of what that impairment is

Childhood Apraxia of Speech

- It is a label for a subset of children with Speech Sound Disorders (SSD) (versus a medical diagnosis)
- Historically, many definitions of CAS have focused on the difficulty or inability to carry out purposeful accurate movements for speech, in the absence of paralysis or weakness of the speech musculature
- Consensus that CAS is due to inefficiency in motor planning and programming processes for speech is increasing, and treatments have been devised to address that level of impairment

So –what does that mean- inefficiency in motor planning and programming

- The term *praxis* is defined as the conception and planning of a motor act and is often used to denote planning and programming of intended movement for speech.
- Sensorimotor planning for speech involves establishing the spatial and acoustic goals
- Sensorimotor programming for speech refers to the actual specification of movement parameters
  - Range and direction of motion
  - Strength
  - Speed
  - Variations in muscle tension

Specification of Movement Parameters

- Basically - instructions for the timing of muscle contraction so that specific structures move in the right direction, at the right time, with the right speed and force to reach a specific articulatory configuration

So – what do we mean by Motor Planning/Programming

- 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
  - 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):
  - The primary difficulty may be with the specification of movement parameters required to make articulatory gestures for the correct and continuous spatial/temporal targets
  - This may be due to difficulty with
    - The processing of afferent proprioceptive information
    - Deficits in the motor planning areas of cortex

The Goal of DTTC

- To improve the efficiency of neural processing for the development and refinement of sensorimotor planning and programing that is required to make articulatory gestures for the correct and continuous spatial/temporal targets
- DTTC includes cueing strategies to maximize proprioceptive processing and provide the practice needed to develop and refine motor programs – including the specification of movement parameters

Appropriate Candidates for DTTC

- DTTC was designed and is most appropriate for **severe** CAS
  - It has been successfully used for children with more moderate CAS
  - It has also been used for children who have particular difficulty with residual sound errors
- 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

- **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
- **DTTC is not appropriate**
  - If the child does not have joint attention
  - If the child does not initiate attempts at gestural or verbal communication
  - If their cognitive level is to low to volitionally try the movements for the utterances

DTTC is designed for the motor planning and programming deficits associated with CAS

- It is beyond the scope of this webinar to discuss all issues related to differential diagnosis
- The following is a brief review of those characteristics associated with the use of the label
- At least several of these characteristics should be observed across tasks to increase your confidence in the child having CAS

CAS Characteristics

- There a a number of characteristics that are now generally accepted to be associated with CAS
- Some of these characteristics – while often seen in children with CAS – are not discriminative
- Others are more discriminative
  - They reflect those characteristics we might expect to see that indicate deficits in movement specification
  - They are seen relatively more often in children with CAS than other speech sound disorders (SSD)

Often present but not discriminative

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Children with delayed speech development or phonologic impairment may also exhibit these characteristics

- Limited consonant and vowel repertoire
- Use of simple syllable shapes
- Frequent omission of sounds
- Numerous errors – poor Standard Scores (SS) on articulation test
- Poor Intelligibility

- Children with all types of SSD may have limited repertoires, use simple syllable shapes or make numerous errors
- Any child with a severe SSD (CAS, phonologic impairment and/or dysarthria) may have poor SS or exhibit poor intelligibility

Characteristics more likely to be discriminative

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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

Characteristics more likely to be discriminative

- Manner Errors
- Intrusive schwa
- Distorted consonants and consonant substitutions

- E.g. Between an/m/ and a /b/
- Occurs both in word final (bedə) and within word (baɪək) positions
- Consonants that are distorted

Characteristics more likely to be discriminative

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

Dynamic Temporal and Tactile Cueing

(DTTC)

Dynamic Temporal and Tactile Cueing (DTTC)

- Designed specifically for children with severe SSD, especially CAS, who were not successful with more traditional forms of therapy
- **Goal**: Improve the efficiency of neural processing for:
  - the development and refinement of motor planning and programming, especially the specification of movement parameters to facilitate acquisition and retention of speech motor skill
  - Provide strategies to enhance retention and habituation

Distinguishing elements of DTTC

- The method is based on auditory and especially visual imitation
- The focus of treatment is on the movement gesture rather than the sound
- **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

Distinguishing elements of DTTC

- Emphasizes *shaping* of movement gestures
  - Makes use of different types of cues
    - Visual – especially attention to the clinician's face
    - Gestural
    - Tactile – not specified, but chosen by the clinician
  - Emphasizes the use of continuous movement transitions for the target utterance and avoids any segmentation of movement within the syllable (e.g. b-oy ([bə.ɔɪ]) for boy ([bɔɪ])

Distinguishing elements of DTTC

1. Emphasizes practice
2. Incorporates PML that facilitate both acquisition of motor skill as well as retention of movement patterns for speech
3. Facilitates improved proprioception
   - Moving more slowly at first to give the brain more time for proprioceptive processing
   - Staying in initial configurations for a time

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

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.

- 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.

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

Because DTTC focuses 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
- 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

DTTC Procedures	Rationale
Simultaneous production ↕ Immediate repetition ↕ Repetition after delay ↕ Spontaneous production	▪ Provides maximum support at first ▪ Emphasizes and makes salient proprioceptive afferent information ▪ Allows for more accurate movement ▪ Fades the amount of support to maximize motor learning

The basic hierarchy

Simultaneous production

⇩ ⇕

Direct imitation

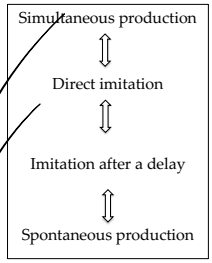
⇩ ⇕

Imitation after a delay

⇩ ⇕

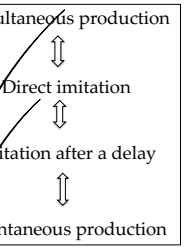
Spontaneous production

At each level of the hierarchy



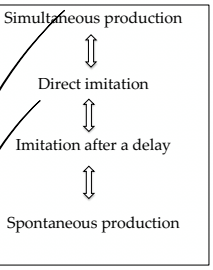
- Start slowly and with continued practice trials, slowly move toward normal rate
- Provide cues as needed
  - Visual
  - Gestural
  - tactile

At each level of the hierarchy



- Provide more specific feedback (knowledge of performance) at first, gradually moving to knowledge of results (right or wrong)
- FADE cues as quickly as possible, as the child produces the movement more accurately and with less effort
- Complete as many practice trials per sessions as possible

At each level of the hierarchy



- When the child is accurate at normal rate, begin to vary prosody
  - Softer and louder
  - With different emotion
- Rationale: provides variability in practice

At Each Level of the hierarchy

When the child has shown

- Accurate movement at normal rate
- Varied prosody
- Shows no effort

Then move to the next level of the hierarchy

Children often have trouble making the move to the next level

(as an example)

Going from Direct Imitation to Imitation after a Delay

Attempt is inaccurate

Add a mime

or

go back to direct imitation

Try again

If successful, go to

Imitation after a delay

Initial Procedure

- Clinician 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 – add other cues

- If the child cannot produce the accurate movement even in simultaneous slower production, you may have to augment simultaneous production with:
  - Phonetic placement strategies
  - Tactile cues
  - Gestural cues
- To improve proprioceptive processing
  - When the child achieves the initial spatial target, have them stay there for several seconds
  - you may want them to relax to a natural position, and then see if they can get back there

Another Strategy

- 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
  - Gradually move toward natural rate
  - Give specific feedback at first, gradually moving to less specific and less frequent feedback

- When the child has simultaneously and accurately produced the target with the clinician, at normal rate, for at least 10 trials – begin to vary prosody
  - The child will not know what you will do so don't expect them to match yours
  - This is just to show how your voice may move around
  - Children often begin to vary their prosody

- When child achieves:
  - No struggle or groping
  - Good accuracy
  - Normal rate
  - Was able to vary prosody at least a bit
- Go 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

DTTC Procedures

- Continue to proceed practice in direct imitation - adding and fading cues as needed
  - Gradually move toward normal, natural rate with repeated practice trials
  - Make sure to fade cues as soon as possible
- As before, when the child is accurate, speaking at normal rate and with no struggle or hesitation, then begin to vary prosody
  - This time the child should try to match your prosody
  - Some children with CAS have great difficulty with prosody – they may need extra work with this outside the DTTC hierarchy

DTTC Procedures

- When the child is accurate at normal rate, and varied prosody for at least 10 trials in the direct imitation level, move to delayed repetition
  - 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, may want to have the child repeat the target several times without intervening stimuli

- During Delayed Imitation
  - As before, always add or fade cues as necessary until the child is accurate
  - When they have maintained accuracy at normal rate for at least 10 trials, begin to vary prosody
  - When the child is accurate and has varied prosody for at least 10 trials, move to spontaneous production

- Elicit the utterance spontaneously
- Soon I will talk about blocked practice (*which is practicing each of the targets without intervening stimuli*) ~ which is what we have been doing with the hierarchy I've just described
  - Those blocks will get smaller (for each target) as the child improves
  - Fewer blocks of practice will be used per session as the child improves
  - At this point, when the target is being produced spontaneously, it should always be random *(one production with no intervening targets)*
    - Elicit with a question or picture
    - Do this randomly sporadically throughout the session as you are doing blocked practice with other targets

- 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**

Fidelity

- Measuring fidelity is extremely important in treatment research
- One aspect of DTTC that may pose problems for fidelity measurements in treatment research is that the clinician is charged with making many on-line clinical decisions, within and across sessions
- Fidelity checklists can be helpful both in clinical research, but also to help clinicians judge to what degree they are implementing the treatment as designed and studied

Example of a Fidelity Checklist Specific to Severe CAS

General Observations per session

_____ Used 4-8 targets
_____ Used modified block organization of practice
_____ Provided fading of feedback
_____ Sat facing child; close to eye level
_____ No distracting items near child

For each target practiced

____ Used tactile cues when appropriate (at least 80% of the time)

____ Started slowly and gradually worked toward normal rate

____ Added cues appropriately at least 80% of the time

____ Faded cues appropriately at least 80% of the time

____ Moved from simultaneous to direct imitation if conditions were met

____ Moved from direct imitation to delayed condition if conditions were met

____ Moved from delayed condition to random spontaneous production if appropriate

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)

Video Examples of DTTC

- Video segments of DTTC treatment can be found on the Mayo Clinic you tube channel
- It is part 6 of an 8 segment video on the nature, diagnosis and treatment of CAS made specifically for parents but have been helpful to clinicians
- The links are in your downloadable handout

Decisions you have to make as you implement DTTC

- ❑Selection of stimuli
- ❑Blocked vs. random practice
- ❑Type, amount and how to fade feedback

Selection of stimuli

- Targets for treatment – they are a **vehicle** for practice as we work to shape accurate movement and therefore improve the efficiency of motor planning and programming
- Choosing targets is important – and makes a difference in the treatment's efficacy and efficiency

Choosing Targets

- There is a large body of research examining target selection in treating SSD
- Most of this literature refers to treating individual sounds
- While we typically choose consonant sounds as targets in speech therapy, choosing movement shapes is more important in treating CAS and involves
  - ❑Using a motor speech exam to determine which vowels are distorted
  - ❑Thinking about syllable shape (CV, VC, CVC, reduplicated syllables, etc.)
  - ❑Thinking about length and phonetic complexity

Initial Stimuli (Targets)

- How many
- Length (syllable shape) and phonetic content?
- Vowel content
- Real vs. non-sense words

How Many

- PML give us direction in deciding how many targets to choose
  - Children with severe CAS have more difficulty with early acquisition of accurate movement patterns
  - To facilitate acquisition, fewer targets allow more massed practice (more practice on each target)
- When using DTTC clinicians are encouraged to choose 5-6 targets for children with severe CAS
  - Practicing only 1 or 2 does not provide enough variability of practice
  - This set size will gradually grow, usually only after a few weeks of frequent treatment

Length (syllable shape)and phonetic content

- Use the motor speech exam to determine their speech motor performance across words that vary in length and phonetic complexity
  - If the child is successful only at CV or VC, use those plus one CVC or reduplicated syllable
  - Choose movement patterns for which they were not successful in motor speech testing, in your choice of initial words, but don't include more than 1 or 2 at first
    - Lip closure
    - Tongue front to back
    - Lips round to neutral or wide

Vowel content

- 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
  - 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.

Non-sense versus Real Words

- For clinicians using DTTC I recommend using real words
- This is especially important for those children who are low verbal or non-verbal or for those who demonstrate very severe deficits in praxis for speech
  - More motivating for the child
  - Functionally important
  - Facilitates retention and generalization

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)**

Very Severe	Severe	Mod-Severe
No	eat	my hat
Hi	No way	I want to eat
Bye	boat	me too
Mom	Bye	movie
Up	Hi Mom	go outside
(3 CV, 1 CVC, 1 VC; two vowels that were distorted)	Mine	book
		happy

Blocked vs. random practice

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How we Organize 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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Random vs. Blocked Practice

- Blocked - Practice each stimuli in a block – that is over and over, with continuous cueing as needed and fading cues as the child improves
- Random - Practice each stimuli once or twice, with no intervening stimuli across the whole set

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Decisions depend on:

- Severity and type of the speech disorder
- Immediate goal:
  - Blocked yields quick development of the skill, *(acquisition)* but poor retention *(motor learning)*
  - Random *(distributed)* takes longer, but get better motor learning

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Schedules of Practice

Blocked practice - facilitates the acquisition phase (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
- As the child improves, move to shorter blocks and finally random practice

How Will Practice be Organized?

- ❑ Blocked – each target practiced in blocks, once each session
- ❑ Modified block – each target practiced in varying lengths of blocks, with selected blocks repeated 1, 2 or 3 times in the session
- ❑ Random practice – each target practiced once, randomly throughout the session

- ➨ Rarely, if ever, do this for only 1 or two stimuli – need more distributed practice; 5 at a minimum for very severe CAS
- ➨ 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

Blocked trials

This is an arbitrary number of trials that will vary depending on CAS severity, difficulty with particular target, and how long the child has been in DTTC therapy

Target Utterance	Practice Block 1	Practice Block 2	Practice Block 3	Practice Block 4	Practice Block 5	Practice Block 6
Hi	20 – 40 trials					
Bye		20-40 trials				
No			20-40 trials			
Up				20 – 40 trials		
Eat					20 – 40 trials	
Mom						20-40 trials

During each block you will be going through the DTTC hierarchy, adding and fading cues as necessary.

You will likely not get through the whole hierarchy in one block at first. Stop when the child is having some success and you've gotten the minimal # of responses

Modified Block: Example 1

This is an arbitrary number of trials that will vary depending on CAS severity, difficulty with particular target, and how long the child has been in DTTC therapy

Target Utterance	Practice Block 1	Practice Block 2	Practice Block 3	Practice Block 4	Practice Block 5	Practice Block 6	Practice Block 7	Practice Block 8	Practice Block 9
Hi	25 – 40* trials			25 – 40 trials			25 – 40 trials		25-40 trials
Bye		15 – 20 trials							
No			15 – 20 trials						
Up					15 – 20 trails				
Eat						15 – 20 trials			
Mom								15 – 20 trials	

During each block you will be going through the DTTC hierarchy, adding and fading cues as necessary. You will likely not get through the whole hierarchy in one block at first. Stop when the child is having some success and you've gotten the minimal # of responses

Modified Block: Example 2

This is an arbitrary number of trials that will vary depending on CAS severity, difficulty with particular target, and how long the child has been in DTTC therapy

Target Utterance	Practice Block 1	Practice Block 2	Practice Block 3	Practice Block 4	Practice Block 5	Practice Block 6	Practice Block 7	Practice Block 8	Practice Block 9
Hi	25 – 40* trials			25 – 40 trials			25 – 40 trials		
Bye		15 – 20 trials							
No			25 – 40 trials			25-40 trials			
Up					15 – 20 trails				
Eat								15-20 trials	
Mom									15 – 20 trials

Type, amount and how to fade feedback

Feedback

Specific- Knowledge of Performance (KP)

- Give specific information about what was right or wrong about the movement
  - "Oh – close your mouth a little"
  - "Not to tight"
  - "Make your lips rounder

Knowledge of Results (KR)

- That was right!
- Not that time
- Not quite – can you fix it?

Varying the
Types and frequency of feedback

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

Special Problems in Treating CAS

- Vowel distortions
- Intrusive schwa

Vowels

- Vowels may be the **most important** target early in treatment for many children with severe apraxia of speech, yet these are infrequently mentioned as a specific target or goal
- Vowel content is related to syllable "shape" and should be considered when choosing initial stimuli – especially for children with severe apraxia of speech

Planning Treatment focused on Vowel Accuracy

- Again – it is important to keep the word **movemen**t in mind as you think about improving vowel accuracy.
  - If we continue to think in terms of "sound errors" and treating sound" production – we'd be tempted to work on vowels in isolation
  - But the vowel is produced in an uninterrupted movement gesture at the level of the syllable
  - That movement will be different – even for the same vowel – depending on the co-articulatory content

Treating Vowels

- Practice should focus on making those movement transitions, in the context of speech, and to perform that movement over and over again.
- At first, the clinician will provide maximum support by providing visual, tactile and auditory models, fading those cues over time, e.g.
  - **Getting the jaw to just the right amount of opening**
  - Adjusting tongue "tightness"
  - Adjusting lip rounding or retraction

- If the child cannot imitate the correct movement gesture for the vowel in context, then it's often helpful to:
  - Do the movement simultaneously with the child – starting more slowly – then gradually increasing rate
  - You may even take out the voice, making just the movement gesture – adding back in the whisper and finally the voice

Eliminating the intrusive Schwa

- Many children with CAS may use inserted schwas
  - Within words (basəball; (baɪək))
  - At the end of words (bedə)
- These are important to treat, as their use constitutes an extra syllable, which greatly impacts intelligibility

A few strategies that have worked for me

- For within word schwa
  - Produce the word slowly and simultaneously
  - Hold the consonant immediately before a little longer (if a continuant)
  - Do the movement pattern without voice
- For word final schwa
  - Produce the word slowly and simultaneously, holding your hand under their jaw to eliminate jaw opening
  - Have them hold a final continuant longer
  - Use your had to stop lip movement with final bilabials

Summary

- DTTC is a motor based treatment for CAS – especially severe CAS
  - The goal of DTTC is to improve the neural processing for sensorimotor planning and programming, especially movement specification, to allow accurate movement gestures at the level of the syllable or longer
  - It is a dynamic procedure that provides maximum support at first, and fades that support as the child improves
  - It is an evidenced based approach in that research has been published showing treatment effects
- There is a great need, however, for additional treatment research, in DTTC as well as in other methods to best serve the needs of our children with CAS