The Nuts and Bolts of Apraxia Therapy

10.13.25
OSSPEAC

Cari Ebert, MS, CCC-SLP

- Neurodiversity-affirming SLP in the Kansas City, Missouri area
- Professional speaker
- Author
- Product developer
- Parent of an Autistic child
- Defender of play-based learning
- 13-year breast cancer survivor

2

Want to learn more?

Visit Cari's Website (cariebert.com)

Subscribe to Cari's Newsletter

Follow Cari on Instagram: @cari.ebert.seminars

Like Cari's Facebook page: Cari Ebert Seminars

Shop Cari's Amazon Store

Listen to Cari's podcast: SLP Talk Show

3

Cari's Podcast

SLP TALK SHOW

Episode 40: Apraxia – An explanation for parents

with *Cari Ebert*
MS, CCC-SLP

4

Disclosures

Nonfinancial Disclosure: Cari has an Autistic son and shares personal experiences in her trainings.

Financial Disclosure: Cari is the co-author of *The SLP's Guide to Treating Childhood Apraxia of Speech* and the creator of multiple speech therapy products that she will briefly reference during this training. She receives royalties from product sales on her website, as well as compensation for presenting this course.

5

The SLP's Guide to Treating Childhood Apraxia of Speech

Effective Therapy Strategies for Toddlers, Preschoolers, and Early School-Aged Children

Dave Hammer, M.A., CCCSLP & Cari Ebert, M.S., CCCSLP
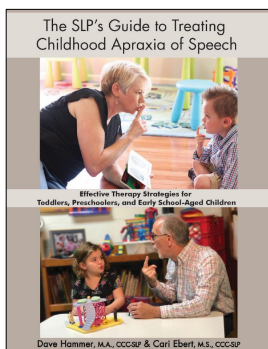
Available at cariebert.com

6

Visual cue cards available at cariebert.com

Apraxia Overview

Speech is a Motor Skill

➔ Speech production is one of the most complex and rapid motor behaviors exhibited by humans. It depends on the precise coordination of more than 100 laryngeal, orofacial, and respiratory muscles (Simonyan et al., 2016).

➔ Intelligible speech requires rapid and accurate alternating movements of the articulators (speed and agility).

➔ Dr. Edythe Strand reminds us that speech production is continuous movement across syllables.

MRI of Speech Production

Labels: Lips, Hard Palate, Tongue, Velum, Alveolar Ridge
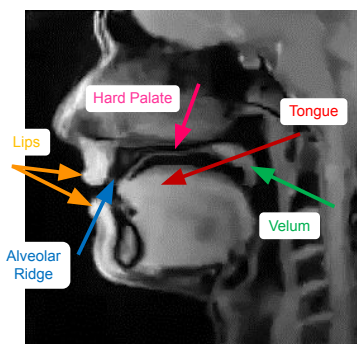
10

Speech Demands

Speech requires rapid and accurate alternating movements of the articulators, demanding both speed and agility).

Because speech production is so complex, it takes years for kids to develop intelligible speech.

11

Definition of CAS

"Childhood apraxia of speech (CAS) is a **neurological childhood** speech sound **disorder** in which the precision and consistency of **movements** underlying speech are impaired in the **absence of neuromuscular deficits** (e.g., abnormal reflexes, abnormal tone)…the core impairment in planning results in errors in speech sound production and **prosody**."

ASHA's 2007 Technical Report

12

Cari's Explanation of CAS

Apraxia is when the brain says 'speak' but the mouth doesn't respond.

13

Praxis

- The root word of apraxia is *praxis*
- *Praxis* is a Greek word for movement
- Praxis is the ability to plan and carry out purposeful movements
- Apraxia is a decrease in the ability to plan and perform those movements
- This is why apraxia is described as a motor planning disorder
- Motor planning means knowing what steps to take, and in what order, to complete a movement task

14

Motor Planning

**Relating this to speech**: Motor planning allows a child to create, use, and combine sounds and syllables to produce new, more complex utterances. Once a speech target has been practiced and is well-rehearsed, it can then be produced more accurately and with greater ease.

This is why repetitive speech practice is essential— talking must become highly efficient and seemingly automatic.

15

Motor planning occurs in the motor cortex in the brain

"Motor" Cortex
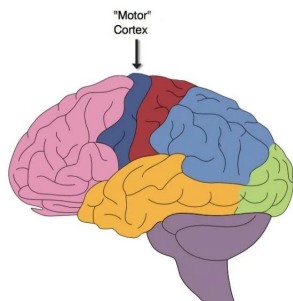
16

The Motor Planning Process

- When first learning a new motor skill, it takes time and effort to experience success.
- We must pay close attention to each step, often failing, receiving feedback, making corrections, and trying again. Over time, we learn to perform the movements more rapidly, more accurately, and more independently.
- Once a motor act has been well-rehearsed, it feels almost automatic—because the brain's motor planning process has become quick and efficient.

17

Types of Apraxia

Limb Apraxia

- Also called *Dyspraxia* or *Developmental Coordination Disorder (DCD)*
- Difficulty planning, coordinating, and executing gross- and fine-motor movements on command

Non-Verbal Oral Apraxia

- Difficulty planning, coordinating, and carrying out oral-facial movements on command

Verbal Apraxia

- Difficulty planning, coordinating, and sequencing sounds necessary for speech on command

18

Motor Performance in Children with CAS
Jenya Iuzzini-Seigel, 2019 & 2022

- Children with CAS are at increased risk for fine and gross motor deficits
- Up to 85% of children with CAS may meet the criteria for DCD
- Children who have difficulty sequencing speech movements often demonstrate difficulty with oral and limb sequencing as well

This research outlines why the SLP will likely need to collaborate with OT and PT colleagues

19

Test for Developmental Coordination Disorder (DCD)

MABC·3
Movement Assessment Battery For Children • THIRD EDITION
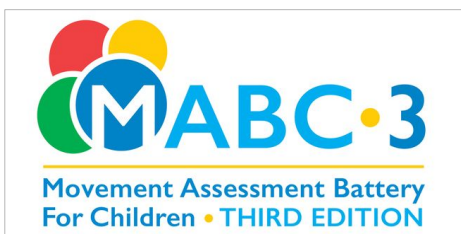
20

Specialized Support

For children with apraxia of speech, learning to talk is challenging due to difficulties with speech motor planning. Therefore, learning to talk will require more time, more focused attention, and more highly specialized practice than other kids need.

⚠ Simply placing kids with CAS in a language-rich environment is not enough to develop speech motor planning skills.

21

The Diagnosis Matters

- The only evidence-based treatment for CAS is speech therapy
- However, speech therapy is not one size fits all
- The diagnosis drives the treatment bus

Treatment

22

Assessment & Diagnosis: Brief Overview

Speech Sound Disorders
ASHA Speech Sound Disorders Portal

Functional (idiopathic/no known cause)

→ Articulation Disorder (motor)
→ Phonological Disorder (linguistic)

Organic (known cause)

→ Motor-Based Disorders (CAS, Dysarthrias)
→ Structural Disorders (related to cleft palate or other craniofacial anomalies)
→ Sensory/Perceptual Disorders (resulting from being deaf or hard of hearing)

**Mixed speech sound disorder

24

Articulation Disorder

- An articulation disorder is a motor-based speech sound disorder that affects the child's ability to accurately produce individual speech sounds.

- Speech production errors occur at the **PHONETIC** level, meaning the child has difficulty accurately producing certain sounds in isolation.

- Articulation errors are considered developmental early on and many kids outgrow them on their own without direct intervention.

- Speech therapy targets are based on developmental speech norms.

25

Developmental Norms: 90% criteria of when English consonants are produced correctly
Crowe & McLeod, 2020

Early 13 (2;0–3;11) = /b, n, m, p, h, w, d, ɡ, k, f, t, ŋ, j/ (all plosives, nasals and glides)

Middle 7 (4;0–4;11) = /v, ʤ, s, ʧ, l, ʃ, z/

Late 4 (5;0–6;11) = /ɹ, ð, ʒ, θ/

26

Phonological Disorder

- A phonological disorder involves predictable patterns of simplification errors.

- The child can make the speech sounds in isolation (at the phonetic level) but has not yet learned the rules for how sounds fit together to make words.

- Speech production errors occur at the **PHONEMIC** level.

- Most phonological patterns are considered developmental early on (initial consonant deletion and backing are atypical patterns).

27

Updated Speechie Lingo

These simplification patterns used to be called **phonological processes** but SLPs now refer to them as **phonological patterns**.

Why the change? The term *phonological processes* is often confused with *phonological processing* (a skill related to early literacy development).

28

Motor-Based Speech Disorders

- Both childhood apraxia of speech (CAS) and dysarthria are neurological speech disorders.
- Neurological sounds like a scary word, but it's not: it just means that talking starts in the 🧠, not in the 👄.
- A motor speech disorder occurs when a child struggles to produce speech because of difficulty with **motor planning** or with **motor execution**.
  - ➔ Motor **planning** difficulty (neurological) = CAS
  - ➔ Motor **execution** difficulty (neuromuscular) = dysarthria

29

Analogy

Think of speech like a road trip:
- Brain is the GPS…creates the plan (motor plan)
- Mouth is the car…carries out the movement (motor execution)

CAS: The GPS (brain) gives unclear or inconsistent directions…the car doesn't know how to get to the destination.

Dysarthria: The GPS gives clear directions, but the car (muscles used for speech) can't drive smoothly because it's weak, slow, or uncoordinated.

30

CAS Assessment Tools

- The DEMSS by Strand and McCauley (available here)

- Dynamic CAS Inventory and Decision Guide by Bjorem Speech (available here)

- Mayo 10+1 Checklist

- Profile of Childhood Apraxia of Speech and Dysarthria (ProCAD)

- Buy Bobby a Puppy
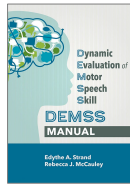
31

Mayo 10+1 Checklist

- The Mayo 10+1 Checklist outlines the speech characteristics most commonly associated with CAS.

- 4+ signs of motor planning struggles over 3+ tasks to consider CAS.

- Click here for a clinical assessment worksheet for SLPs to use when making a differential diagnosis.

⚠️ Many of these traits also occur in dysarthria, so this checklist alone will not support differential diagnosis.

32

Mayo 10+1 Checklist

1. Vowel distortions
2. Distorted substitutions
3. Difficulty achieving initial articulatory configurations or transitionary movement gestures
4. Equal stress; lexical or phrasal stress errors
5. Syllable or word segregation/segmentation
6. Groping or trial-and-error behavior
7. Intrusive schwa
8. Voicing errors
9. Slow speech rate and/or slow DDK
10. Increased difficulty with multisyllabic words
11. Inconsistency on repeated trials of words/utterances

33

Differential Diagnosis

- When an SLP suspects a motor speech disorder, it is essential to determine whether the child presents with CAS, dysarthria, or both.

- Children with CAS often perform better on automatic speech tasks (e.g., counting, familiar songs) than on volitional speech tasks (novel productions on command). Children with dysarthria will *not* show a difference in speech production on automatic vs. volitional speech tasks.

- The ProCAD is a structured assessment tool designed to support this differential diagnosis.

34

Reference

Click the document to download and read 🔗
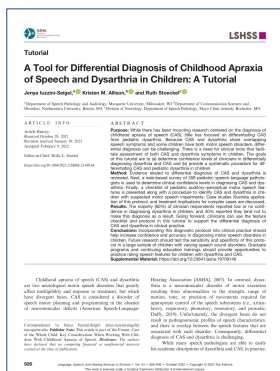
35

ProCAD

The Profile of Childhood Apraxia of Speech and Dysarthria (ProCAD) is an auditory-perceptual feature rating checklist in which the SLP marks whether certain traits are *present*, *absent*, or *unclear* in three major domains:

1. Inconsistency (more indicative of CAS)
2. Transitions and prosody (discriminative for CAS)
3. Execution features (more indicative of dysarthria)

Click here for the link (it's free!).

36

Say "Buy Bobby a Puppy" 5x

Iuzzini-Seigel et al., 2017
https://doi.org/10.1044/2016_JSLHR-S-15-0184

"Token-to-token inconsistency of monosyllabic words and the phrase "buy Bobby a puppy" was sensitive and specific in differentiating children with CAS and speech delay whereas inconsistency calculated on other stimuli (e.g., multisyllabic words) was less efficacious in differentiating between these disorders."

39

To Diagnose CAS…

To diagnose CAS, most experts recommend that at least 4 signs of motor planning struggles be observed across at least 3 different speaking tasks.

Example

Struggles may be evident in:

- Structured testing (e.g., DEMSS)

- Naturalistic speech (e.g., conversation)

- High-demand probe (e.g., *Buy Bobby a Puppy*).

38

Speech Motor Delay

- Speech Motor Delay (SMD) is a recently proposed childhood motor speech disorder characterized by imprecise and unstable speech, prosody, and voice (Shriberg et al., 2019). It is *not* an official diagnosis.

- Speech motor delay is identified when a child's speech motor skills are slower than expected to develop but they do not meet the criteria for CAS or dysarthria (McCabe et al., 2024).

- Children with SMD often respond favorably to speech therapy and tend to make more rapid progress than kids with CAS or Dysarthria.

39

Mixed SSD

- Children may have more than one speech disorder at the same time, and it can be challenging for the SLP to differentiate and disentangle these (McCabe et al., 2024).
- Some children with CAS may require a combination of:
  → Speech motor planning goals
  → Phonological goals
  → Articulation goals

40

Treatment Overview

Sign up for the apraxia freebie!

42

Key Points from Dr. Strand's 2020 DTTC Article

Speech is organized around movement gestures, not isolated phonemes.

These gestures are coarticulated, meaning they blend continuously across syllables.

The therapeutic focus in CAS should therefore be on movement transitions and sequencing, not just practicing individual sounds.

43

Focus of Therapy: Sounds, Patterns, Movement, Execution

Articulation Therapy: Focuses on accurate production of individual **sounds**.

Phonological Therapy: Focuses on eliminating error **patterns** in the sound system.

CAS Therapy: Focuses on planning and sequencing **movement** gestures across syllables.

Dysarthria Therapy: Focuses on **execution** of speech through strength, coordination, and control.

44

General CAS Treatment Guidelines

- Focus on movement sequences, not isolated phonemes (think coarticulation, not articulation).
  - Emphasize speech gestures and transitions, not just correct sound production.
  - Model and cue the whole movement (e.g., back to front" or "round to smile") instead of drilling single sounds in isolation.
- Base speech targets on the child's current phonetic inventory and preferred syllable shapes, rather than developmental speech norms (meet the child where they are by focusing on what they can already do).

45

- Keep sessions dynamic and engaging so children can sustain high trial counts without fatigue.
- Avoid segmenting target words into individual sounds or syllables. Apraxia therapy focuses on *moving* across sounds, syllables, and words without pausing.
- Adjust speech targets so they are challenging yet achievable with skilled scaffolding (determine each child's optimal challenge point).
- Incorporate prosodic variation (e.g., melodic intonation and stress patterns) early in the therapy process.
- Focus on using play *as* the therapy activity rather than using play *in* therapy as a reinforcer (avoid referring to repetitive speech practice as *work*).

46

- Practice speech targets in unison if direct imitation is not successful.
- Conduct speech practice face to face so the child can watch your articulatory movements (Kent, 2004).
- Incorporate a variety of multisensory cues to support speech motor planning and programming.
- Ensure accurate speech practice, as repeated errors can strengthen incorrect motor patterns.
- Use an evidence-based treatment approach, such as DTTC or ReST.
- Apply the principles of motor learning (PML) to guide your therapy practices (consider motor performance vs motor learning).

47

Motor Performance and Motor Learning

➔ **Motor performance** – Occurs during skill acquisition; involves temporary changes in movement within a practice session; performance varies.

➔ **Motor learning** – Involves generalization of skills; reflects permanent changes in movement; performance is consistent over time.

When applying the Principles of Motor Learning (PML), therapy should be matched to the phase: use one set of strategies during skill acquisition, and another during skill generalization.

48

🔊 PML in Treatment of Motor Speech Disorders

Motor learning is related to several factors:

1. **Pre-practice:** Preparing the learner for the practice session.

2. **Target Selection:** Choosing appropriate targets to optimize learning.

3. **Conditions of Practice:** How practice is structured.

4. **Conditions of Feedback:** How and when feedback is provided.

Maas et al., 2008

49

🔊 Pre-Practice for Minimally Speaking Kids

Prepare the learner for the practice session by ensuring the following skills:

- Motivation to participate in the practice session

- Focused attention to the talking task

- Ability to attempt verbal imitation

- Tolerant of different types of cueing

- Engagement with the SLP and attention to the speaker's mouth (not necessarily eye contact)

52

We must focus on regulation and connection with the child before working on motor speech skills (Moore et al., 2024).

51

Pre-Practice for Older Kids

Pre-practice sets the stage for successful motor learning before intensive practice begins. It ensures the child understands *what* to do and *how* to do it before high-repetition drills.

Establish Understanding of the Target Movement

- Explain and model the goal so the child knows what accurate is (e.g., "We're going to make your mouth go from round to smile without stopping").
- Use clear, simple language and developmentally-appropriate explanations.

52

Demonstration and Modeling

- Provide accurate models of the full movement, not segmented sounds.
- Encourage the child to watch your face closely (face-to-face positioning).

Cues and Supports

- Pair visual, tactile, auditory, semantic, and kinesthetic cues with speech tasks.
- Ensure the child can associate cues with intended movements (not all cues will work with every child…they have to make sense).

53

Ensure Readiness and Accuracy

- Use slower rates, simultaneous productions, chaining, and other strategies to help the child achieve correct movement patterns before diving into repetitive speech practice.
- Avoid letting the child repeatedly practice incorrect productions.

Motivation and Engagement

- Make the task meaningful and motivating to increase focus and effort.
- Use functional, relevant words when possible.

54

Target Selection

- Base speech targets on the child's current phonetic inventory, not on developmental speech norms. The goal is to build successful motor plans using sounds the child can already produce or approximate—not necessarily those expected for their age.
- Limit the number of targets. A small set of carefully chosen speech targets (about 5) is ideal for intensive, high-repetition practice.
  - For very young children or those with intellectual disabilities, even fewer targets may be more appropriate.

55

- Choose powerful, high-frequency words and phrases that are:
  – Personally meaningful
  – Intrinsically motivating
  – Likely to occur in daily routines
  – Useful for initiating or responding in social interactions

Examples: *Pizza, Minecraft, C'mon, Wanna play?, Gotta go, Happy birthday, Whatcha doin'?*

Don't fear phrases!

56

Children with apraxia of speech must become **communication risk takers** before engaging in repetitive speech practice. They need to feel safe, connected, and confident enough to *try*—even if their speech isn't perfect yet.

Make sure the risk is worth the effort by choosing speech targets that the child wants to say because they are fun, functional, and personally meaningful!

57

Conditions of Practice

These elements shape *how* practice is delivered and directly affect acquisition, retention, and generalization of motor speech skills.

- Amount of practice
- Distribution of practice
- Variability of practice
- Schedule of practice

58

Amount of Practice

More is better

– Low number of trials: Fewer practice trials = poorer retention

– High number of practice trials = greater retention (focus on fewer targets, more trials, fewer breaks, shorter, more frequent practice sessions)

✔ Research supports shorter, more frequent sessions over less frequent, longer sessions (Viscomi, 2021; Edeal & Gildersleeve- Neumann, 2011).

High numbers of correct repetitions are essential to build and stabilize motor plans.

59

From the ASHA Practice Portal on CAS

➡ Treatment dosage for CAS is consistent with principles of motor learning. Given the need for repetitive production practice in motor speech disorders, intensive and individualized treatment is recommended.

➡ If you work in schools, put your artic and phono kids in groups, but your students with CAS need individualized sessions.

60

Distribution of Practice

Massed vs. Distributed (dose frequency/intensity)

– **Massed**: Concentrated practice of a speech target (e.g., 100 trials in one session); more intensive practice is best for skill acquisition because it builds a strong foundation in early learning

– **Distributed**: Practice is spread across sessions (e.g., 100 trials over three 20-minute sessions… can include home practice); supports retention and generalization of speech skills

Start with massed practice for new speech targets, then shift to distributed practice as accuracy improves.

61

Variability of Practice

Constant vs. Variable (one vs. multiple versions of a movement)

– **Constant:** Practice the movement pattern in one context (best for skill acquisition)

– **Variable:** To encourage generalization, adapt the movement pattern of speech targets by varying:

-Phonetic contexts (such as producing /ni/ in the target word Nemo and then in bunny, Annie, and sneeze)
-Prosodic contexts (comment vs. question)
-Types of talking tasks (requesting vs. labeling)

62

PML

Schedule of Practice

Blocked vs. Random (one vs. multiple targets)

– Blocked: One target practiced repeatedly before moving to the next (best for skill acquisition)

– Random: Intermix speech targets during practice session (best for generalization)

Blocked practice

Random practice

63

Conditions of Feedback

Feedback is critical for shaping accurate speech motor patterns and guiding the child toward independent, self-monitored speech. The way feedback is provided directly affects how new speech movements are learned and retained.

- Type
- Frequency
- Timing
- Control

64

Type of Feedback

Knowledge of performance (**KP**) vs. knowledge of results (**KR**) feedback

- **KP feedback**: Tells the child specifically *what* they did right or wrong ; describes how the movement was performed (best for skill acquisition)

- **KR feedback**: Tells the child *if* they were right or wrong; describes the outcome of the attempt (best for skill generalization)

65

Feedback Examples

KP Feedback

🗣 I saw you round your lips that time!

🗣 Oops…you didn't lift your tongue tip up.

🗣 Good job turning your motor on!

🗣 Next time open your mouth wider.

KR Feedback

✔ Good job!

✔ Close…try again.

✔ Nailed it!

✔ Not quite…fix it.

✔ That was it!

✔ SLP makes confused face.

66

Frequency of Feedback

High frequency vs. reduced frequency

– **High-frequency feedback:** providing feedback after every attempt facilitates skill acquisition (be aware that it can lead to prompt dependence)

– **Reduced-frequency feedback:** providing feedback after every few trials or intermittently supports retention and generalization by encouraging internal monitoring

Fade feedback over time to promote independent, self-regulated speech production.

67

Timing of Feedback

Immediate vs. delayed feedback

– **Immediate feedback**: Best for skill acquisition; helps shape accuracy in real time

– **Delayed feedback**: Important for generalization; encourages the child to reflect on their own performance and supports motor learning consolidation

A short delay (a few seconds) before feedback helps build awareness and self-correction.

68

Control of Feedback

Clinician-controlled vs. client-controlled feedback

– **Clinician-controlled feedback:** SLP provides feedback to the client; best for skill acquisition

– **Client-controlled feedback**: Client self-analyzes their speech productions; necessary for skill generalization

69

Evidence-Based Treatment Approaches for CAS

For children who can attempt verbal imitation, two motor approaches that have the strongest evidence include:

1. Dynamic Temporal and Tactile Cueing (**DTTC**): This is a *look, listen, do what I do* method that uses a cueing hierarchy. (Developed by Dr. Edythe Strand)

2. Rapid Syllable transitions (**ReST**): This method involves repetition of varied sequences of nonsense syllables to train motor planning flexibility (sounds, beats, smoothness). Use with older kids who have lots of speech but are highly unintelligible. (Developed by Dr. Patricia McCabe at the University of Sydney)

70

Apraxia Training Links

DTTC Training
www.childapraxiatreatment.org

ReST Training
www.rest.sydney.edu.au

71

DTTC Hierarchy
childapraxiatreatment.org

Simultaneous Production (*Let's say it together*)
   Slow rate → Regular rate → Vary prosody (heavy cueing)

⬇ *Reduce cues if accurate*

Direct Imitation (*Say it after me*)
   Slow rate → Regular rate → Vary prosody (moderate cueing)

⬇ *Fade cues further*

Delayed Imitation (*Wait until I point to you*)
   Regular rate → Vary prosody (minimal cueing)

⬇ *Remove cues*

Spontaneous Production (*no cues unless breakdown occurs; elicit targets naturally throughout session while working on other goals*)

72

Motor-Based Therapy Goals

Motor Planning Goal Examples

- For a set of 5 target words/phrases, the child will accurately plan and sequence simple syllable shapes (such as CV, VC, CVC, and $C_1V_1C_1V_1$) in unison with the SLP, producing at east 20 accurate trials per session across 3 consecutive sessions, with fading multisensory cues.

- For a set of 5 target words/phrases, the child will accurately plan and sequence simple syllable shapes (such as CV, VC, CVC, and $C_1V_1C_1V_1$) in direct imitation of the SLP, producing at east 20 accurate trials per session across 3 consecutive sessions, with no more than 1 cue.

74

- For a set of 5 target words/phrases, the child will accurately plan and sequence simple syllable shapes (such as CV, VC, CVC, and $C_1V_1C_1V_1$) in delayed imitation of the SLP (e.g., after a brief pause or gesture cue), producing at east 20 accurate trials per session across 3 consecutive sessions, with no more than 1 cue.

- For a set of 5 target words/phrases, the child will accurately plan and sequence simple syllable shapes (such as CV, VC, CVC, and $C_1V_1C_1V_1$) in spontaneous production (elicited naturally during play or conversation), producing at east 20 accurate trials per session across 3 consecutive sessions, without cues.

75

- Using the DTTC hierarchy, child will accurately plan and sequence all movement gestures for 20 target words or phrases, progressing moving from simultaneous production, to direct imitation, to delayed initiation, and finally to spontaneous production.
- Using the DTTC hierarchy, child will produce accurate movement gestures across syllables for 5 target words/phrases, achieving at least 20 accurate trials per session across 3 consecutive sessions.
- Child will self-correct errors on target words following *Knowledge of Results* feedback from the adult listener.
- Child will self-evaluate the accuracy of productions on 20 well-rehearsed target words/phrases.

76

For Older Children

- Encourage participation in target selection; help them identify powerful, high frequency target words and phrases that naturally occur during their day (include names of friends and family, favorite things, and vocabulary from the curriculum and homework)
- Build self-awareness and ownership; make sure older kids know specifically *why* they are in speech therapy
- Empower older kids to collect their own data and monitor their own productions

77

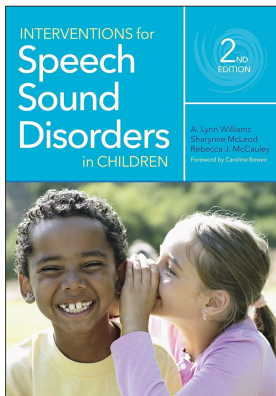# Data Collection: Probe Data
(Williams, Mcleod, & McCauley, 2021)

- Don't get hung up on collecting data during every activity in the speech therapy session.
- Instead, collect probe data, which is an alternative to continuous data collection. Choose a few target words to elicit at the beginning of the session and determine the testing condition (in imitation, spontaneous, when answering a question, etc.).
- Consider shifting away from binary scoring using +/- (accurate/inaccurate) to multidimensional scoring (0 = inaccurate, 1 = close, 2 = accurate).

78

- Progress can also be measured based on how many cues the child needs to be successful.
- Probe data helps the SLP determine when to shift the conditions of practice (moving from imitation to spontaneous). It also signals when a target has been mastered and can be moved out of the rotation.
- If you see the child more than one session per week, you only need to do probe data collection one time each week. If you see the child only once per week, take probe data at the beginning of every session.
- See page 563 in the Williams, McLeod, McCauley book for more support on multidimensional scoring.

79

The SLP Bible

INTERVENTIONS for
Speech
Sound
Disorders
in CHILDREN

2ND
EDITION

A. Lynn Williams
Sharynne McLeod
Rebecca J. McCauley
Foreword by Caroline Bowen

80

Motor-Based Therapy Strategies and Activities

- For children with apraxia, repetitive motor speech practice is the key to acquiring intelligible speech–but repetitive speech practice isn't exactly fun.

- What do SLPs do to make something intrinsically not fun, fun? This is the million- dollar question!

- What strategies and activities do you currently use to make your therapy sessions for children with CAS/sCAS more engaging and effective?

82

1. Start with AAC

Before addressing speech motor planning skills in children with limited or highly unintelligible speech, SLPs need to provide consistent and reliable communication by offering robust AAC until their motor speech system "kicks in."


83

What Makes an AAC System Robust
(Kate McLaughlin, The AAC Coach)

- Lots of words and lots of different kinds of words
- Used for a wide range of functions (not just to request or get basic needs met)
- Supports grammar and literacy
- Option for pre-programmed messages for high frequency phrases and responses
- Well organized
- Able to grow language over time
- Access to full alphabet and word prediction
- Always available

84

Linguistically robust AAC systems to consider (not an exhaustive list)

- LAMP Words for Life
- TouchChat
- CoughDrop
- Proloquo2Go
- TDSnap
- Avaz AAC
- PODD Books
- Weave Chat
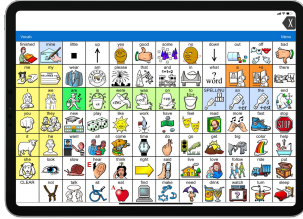
85

Do you know about Weave Chat?
(it's free!)

86

Getting Started with a Device

Considerations for emergent AAC device learners:

- Build an authentic connection by learning about the child's interests and sensory preferences
- Model AAC use without pressure → provide rich exposure through aided language input (a partner device can be helpful)
- Ensure unrestricted access to AAC and encourage exploration and "babbling" on the device
- Embed AAC in daily routines where communication is functional and motivating (not just to request)

87

Don't Be a Gatekeeper

If someone dictates how a child may communicate, controls which words are available, or withholds items to coerce compliance, that person is acting as a *gatekeeper* of communication.

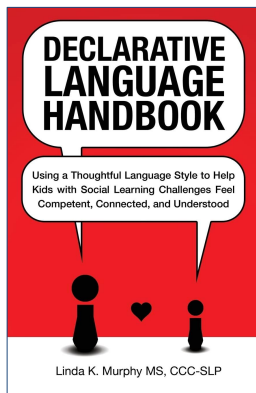This is unacceptable because communication is a basic human right.

Click here to download the *Communication Bill of Rights*.

88

2. Reduce the pressure to speak

- Pair talking tasks with AAC to reduce the pressure to speak on command.
- Meet the child where they are at with their motor speech development.
- Avoid instructing the child to say words. Instead, provide opportunities for the child to talk, but without any pressure to do so (*Rule of 3*).
- Limit the number of test-like questions. Life is not a quiz! Replace imperative language with declarative language.

89

DECLARATIVE LANGUAGE HANDBOOK

Using a Thoughtful Language Style to Help Kids with Social Learning Challenges Feel Competent, Connected, and Understood

Linda K. Murphy MS, CCC-SLP

Highly recommended resource

90

3. Establish a trusting relationship

- Create a safe, positive learning environment to foster attention, motivation, and trust. Focus on building a growth mindset (*talking is hard, but you can do hard things…and I'm here to help*).

- Avoid using behaviorist strategies in an attempt to coerce speech (such as withholding items from the child because they didn't say the target word).

- When the child is struggling, become their voice and say the word(s) you think they would say in the moment if they could.

91

4. For children who don't yet have verbal imitation, start by strengthening non-verbal imitation

- Nonverbal imitation is a foundational skill.

- Many children with CAS have motor planning difficulties throughout the whole body.

- As we build the child's non-verbal imitation skills, we also build their confidence. Confident kids are more willing to take risks. Creating communication risk takers is what early speech therapy is all about.

92

Strategies and activities to support non-verbal imitation skills

- Imitate what the child does and says (technically called contingent imitation)

- Encourage the child to imitate others during play by using declarative language ("Oh look, he's jumping!)

- Introduce songs and fingerplays with actions

- Encourage imitation of gestures and signs

- Play "Simon Says" or "Follow the Leader"

- Read books that encourage imitation skills (*Where's Spot?, Hi-Five Animals, Elmo Says…*)

93

Suggested Action Songs and FingerPlays

- Teddy Bear, Teddy Bear
- Row, Row, Row Your Boat (with additional verses)
- Wheels on the Bus/Animals on the Bus
- If You're Happy and You Know It
- Baby Bumblebee
- Twinkle Twinkle Little Star
- Itsy Bitsy Spider
- Head, Tummy, Knees & Toes
- 5 Little Monkeys Jumping on the Bed

94

Teddy Bear

Teddy Bear Teddy Bear Turn Around
Teddy Bear Teddy Bear Touch the Ground
Teddy Bear Teddy Bear Show Your Shoe
Teddy Bear Teddy Bear That Will Do

Teddy Bear Teddy Bear Go Upstairs
Teddy Bear Teddy Bear Say Your Prayers
Teddy Bear Teddy Bear Turn Off the Light
Teddy Bear Teddy Bear Say Good-Night

95

5. For the child who rarely vocalizes, help them find their voice

Before working on speech production, SLPs need to help the minimally speaking child become a communication risk taker.

Help me find my voice

96

Strategies and activities to help children find their voice

- Respond to all vocalizations produced by the child
- Encourage vocal turn taking using voice amplifying toys, such as an empty bucket, echo microphone, or megaphone

voice amplifying toys

97

- Play the "ahhh" game with a toy doctor kit and a flashlight
- Use kazoos to elicit intentional vocalizations (kazoos are awesome tools because they require the child to motor plan air flow + simultaneous phonation)
- Encourage vocal play (blowing raspberries, clicking tongue, blalling, etc.)
- Pair attention getting sounds with movement activities (ooohhh, grunting, ewww)
- Sing additional verses to Row, Row, Row Your Boat

98

Additional Verses to Row Your Boat

Row, row, row your boat
Down the jungle stream
If you meet a crocodile,
Don't forget to scream!
AAAHHHHHHHHHHH!

Row, row, row your boat
Gently back to shore
If you meet a lion,
Don't forget to roar!
ROOOOAAARRR!

101

6. Increase awareness of articulators (for children with ⬇ body awareness)

By increasing a child's awareness of their lips, tongue, and jaw (i.e., articulators), we aim to enhance the effectiveness of phonetic placement cues during speech therapy.

🛑 **Important Note**: *We are not using non-speech oral motor exercises (NSOME) to improve speech production, but to increase body awareness. NSOME are not recommended to improve speech motor planning skills (McCauley et al., 2009) because speech is not a series of isolated movements (Nip et al., 2010).*

100

## Strategies and activities for increasing articulator awareness

- Introduce modified animal "sounds" (fish, dog, giraffe) to increase awareness of lips and tongue – Cari's Silly Sounds cards

- Engage in mirror play while making funny facial expressions
- Offer lip balm to increase awareness of the lips
- Play the "Blah" game to increase awareness of the tongue

101

- Use books that emphasize oral-facial movements.
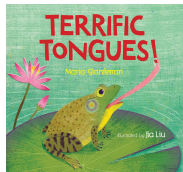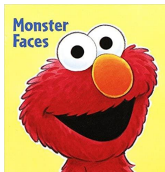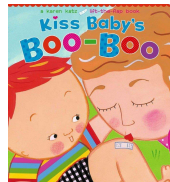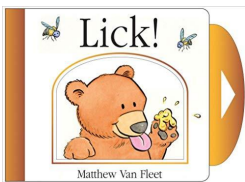
102

7. Establish focused attention to the speaker's mouth

- Encourage the child to attend to the speaker's mouth as speech targets are modeled so they can *visualize* the speech movements.

- If children with apraxia could acquire intelligible speech by just *hearing* other people talk, they wouldn't need speech therapy.

- Hold desired items next to your mouth to draw the child's attention to how you move your lips, tongue, and jaw.

103

- Use exaggerated facial expressions and an animated voice to draw attention toward the speaker's face.

- Engage face to face with the child when modeling speech.

- Be specific…instead of saying, "Look at me" it may be more beneficial to say, "Look at me for help" or "Watch how I move my mouth." (Don't ever focus on eye contact!)

- Play games that involve the child looking at your face (e.g., the A-CHOO! game with littles or Hedbanz game with older kids).

- Wait silently until the child looks at your mouth.

104

- Put a sticker on your nose.
- Wear a silly hat or giant clown glasses.
- Wear bright red lipstick.
- Read books with child facing the adult.

105

- If the child is hesitant to watch your mouth when you speak, try playing in front of a mirror to encourage indirect eye gaze. Mirror use should be low pressure. The goal is to get the child to watch your speech movements indirectly through the mirror.

8. Engage in playful, low pressure activities

- Make learning to talk fun and engaging, not boring and monotonous.
- Be interesting and animated.
- Follow the child's lead.
- Know the child's interests and sensory preferences (figure out what gives each child their "brain tingles").
- Design attention-grabbing activities that fascinate kids.

Attention-Grabbing Therapy Activities

- Toys that do unexpected things
- Things that pop, go, stack, and fall
- Toys that connect (marble runs, Magna-Tiles, Squigz, Lego's)
- Miniature toys
- Themed toys
- Songs and fingerplays
- Interactive books
- Silly sound effects
- Sensory-based play

ooooh!

DON'T PUSH THE BUTTON!
Bill Cotter
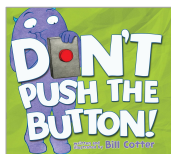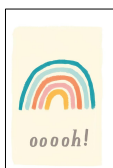
9. Use verbal shaping

- Use verbal shaping early on to teach the child to simplify words…allowing them to produce word approximations. [Nancy Kaufman's work]

- We are teaching kids with apraxia to talk the same way typically developing children learn to talk–by using simplifications/phonological patterns) and then verbally shaping them into the adult versions of words.

- Explain to parents/teachers the difference between speech simplification and baby talk ("wawa" vs. "dwinkie poo").

109

Use the Speech Simplification Strategy to Teach Word Approximations

Target Word	Simplification	Phonological Pattern
Eat	ee	Final consonant deletion
Cookie	tootie	Velar fronting
Water	wa-wa	Reduplication
Blue	boo	Cluster reduction
Butterfly	bu-fy	Cluster reduction; syllable reduction
Potato	tay-doh	Weak syllable deletion

110

10. Pair play-based movement with talking tasks

- Incorporate play-based movement into talking tasks to help regulate the child's nervous system.

- Speech is a motor skill…so movement is a powerful strategy to support motor planning.

- Movement is a better choice than tangible reinforcers to address diminishing attention and participation in repetitive speech practice. Sliding and rhythmical swinging are powerful speech therapy activities!

111

11. Use multisensory cues

- Five common types of cues used by SLPs include visual, auditory, tactile, semantic, and kinesthetic.
- When cues are used in combination, this is referred to as multisensory cueing.
- Multisensory cueing allows the SLP to fade the cues systematically, one at a time.

112

Multisensory Cues to Support Speech Motor Planning Skills

a. **Verbal cues**: model the target word, say target words in unison, add prosodic cues, use verbal shaping, provide the first sound of the target word, model correct vs. incorrect (I say…You say), use forward chaining (won-wonder-wonderful) and backward chaining (na-nana-banana)

b. **Tactile cues**: touch child's face, use tongue depressors or lollipops, PROMPT

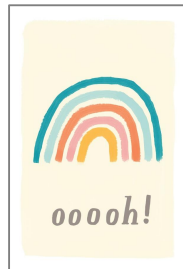c. **Semantic cues**: sound metaphors, phrase completion/cloze procedures, phonetic placement cues

113

d. **Kinesthetic cues** (body awareness and movement cues): Turtle Vowels, Sounds in Motion, Visual Phonics, Lively Letters, Talk Yoga, transition cues (string with a knot at the end), pair movement with talking tasks (*Whee!* on a slide or *Boing! w*hile bouncing on a ball)

e. **Visual cues**: oral posturing, gestures, signs, hand cues, graphic cues, make sounds more visible/ exaggerate articulatory movements, hold desired items next to speaker's face, mirror use, face-to-face seating during talking tasks, mouth the target word without voicing, pair talking tasks with pictorial cues (Bjorem Speech Sound cues, Cari's Silly Sounds cards, Talking Letters)
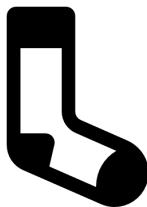
114

Visual Cue Cards

Cari's Silly Sounds are 4" x 6" visual cue cards containing speech targets with simple syllable shapes

115

CARI'S SILLY SOUNDS

Visual cue cards to support early speech development

ooooh!

116

Example of Multisensory Cueing + Fading

Target word: SOCK

117

- There is neurophysiologic evidence that motor systems are activated by observing or imagining movement.

  Visual cue! ↗ (Smith & Goffman, 2004)

- Dr. Strand's recommendation: Maximize the child's attention to your face
  - Use objects that can be held near your mouth
  - Avoid using pictures and games on the table that take the child's attention away from observing your visual model
- SLPs use visual cue cards to support speech motor planning. Avoid calling them flashcards!

118

12. Focus on coarticulatory transitions

- Coarticulation refers to the interweaving movements between sounds, syllables, and words (the opposite is segmentation).
- The spaces used in written language are not present in spoken language because of coarticulatory transitions. (Come_on vs. C'mon…consonant-vowel liaison.)
- Coarticulatory transitions are the focus when supporting kids with apraxia. Think speech movements, NOT individual speech sounds.

119

Coarticulation

Segmented	Coarticulated
I_am_three	Iyamthree
Wa_ter	Wadder
Pa_tty	Paddy
Bu_tter	Budder
Got_to_go	Goddago
I_don't_know	Idohno
I_want_to	Iwanna

Pacing boards often lead to segmented speech

120

Avoid segmentation!

- Avoid separating speech movements into individual sounds (remember… speech is continuous movement!)

    Ex: b-a-t (NO NO NO!)

- Temporarily draw out the vowel sounds in the word to allow more time for the child to plan the speech movements (but speed up as soon as possible to keep prosody in check)

(literacy programs teach segmentation…see Cari's social media post from 3/21/25 for helping kids with CAS on their reading journey)

121

Example: Target word "bat"

No segmentation!

We want coarticulation!

"b - a - t"

"baaaat"
"baaat"
"bat"

122

Be careful about target selection…try to avoid voiced final consonants or the dreaded word-final schwa will emerge!

"bug-<u>uh</u>"

123

13. Increase the child's phonetic inventory

- We need to teach the child *how* to move their articulators to make *all* the speech sounds (both consonants *and* vowels).

- The focus should be on eliciting *new* movements with the articulators and reducing reliance on the default sound or word.

- This is the only time the SLP will focus on sounds in isolation.

124

Pro Tip

Coach colleagues and caregivers to avoid dropping the jaw when modeling consonant sounds in isolation:

/b/ not "buh"
/m/ not "muh"
/g/ not "guh"
/ɹ/ not "ruh"
/t/ not "tuh"

125

Strategies and activities for increasing the child's phonetic inventory

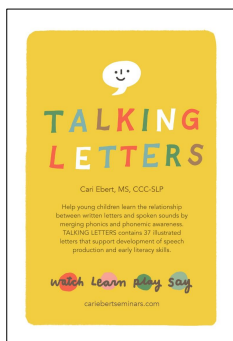- Use the Bjorem Speech Sound Cues (original blue box) and a mailbox to elicit speech sounds in isolation

126

- Watch the Letter Factory video to teach letter names and sounds
- Use books that emphasize speech sounds (be careful with alphabet books…they are often inaccurate!)

"S" IS FOR SHARK
SAID NO SLP EVER
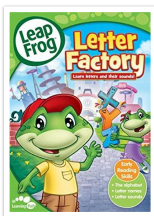
- Teach letter sounds simultaneously with letter names using Cari's *Talking Letters* (alphabet with 37 letters)
- Each card is held next to the speaker's mouth as visual cues when modeling the letter sound

TALKING LETTERS

Cari Ebert, MS, CCC-SLP

Help young children learn the relationship between written letters and spoken sounds by merging phonics and phonemic awareness. TALKING LETTERS contains 37 illustrated letters that support development of speech production and early literacy skills.

Watch Learn Play Say

cariebertseminars.com

14. Consider facilitative contexts

- Inconsistent speech productions may be a result of contextual influences (Kent, 1982). In other words, neighboring sounds can influence the production of each other.
- "Vowels can create a naturally facilitative context for accurate consonant production" (Farquharson, 2024).

✨ Be sure to follow Dr. Kelly Farquharson from FSU @classlab_kelly for her Phonetics Friday posts on Instagram!

130

Facilitative Contexts: Front Vowels
Dr. Kelly Farquharson (2024)

Front vowels facilitate accurate production of alveolars /t, d, n, l/ and **help avoid lip rounding** (because all front vowels are unrounded)

 /i/ as in "beet"
/ɪ/ as in "bit"
/eɪ/ as in "bait"
/ɛ/ as in "bet"
/æ/ as in "bat"

131

Facilitative Contexts: Back Vowels
Dr. Kelly Farquharson (2024)

Back vowels facilitate accurate production of velars /k, g/ and **encourage lip rounding** (because 4 of the back vowels are rounded)

 /u/ as in "boot"
/ʊ/ as in "book"
/oʊ/ as in "boat"
/ɔ/ or /ɑ/ as in "bought" (depending on dialect)

132

15. Address prosody

- Consider the *Prosody Treatment Program* by Joseph Rothstein. There is a section for preschoolers and a section for school age children.

- Practice target words by varying the prosody/suprasegmentals:
  - question vs. comment
  - loud vs. quiet
  - Daddy bear vs. Mommy bear vs. Baby bea
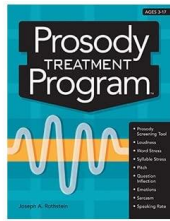
133

- Focus on sound effects (animal sounds, vehicle sounds, people sounds) during play and story time. Sound effects are a fun, effective way to:
  - Elicit intentional sounds
  - Make talking tasks engaging
  - Support the transition from pre-speech to speech sounds
  - Develop verbal imitation skills
  - Encourage prosodic variation

- Use "Cari's Silly Sounds" cards to draw attention to the speaker's mouth while making playful sound effects.
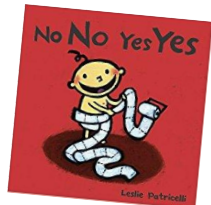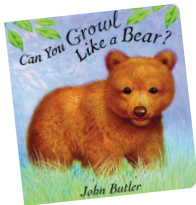
134

135

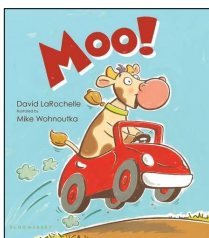## 16. Use books and songs that support speech motor planning

- Look for books and songs that…
  - Emphasize sound effects
  - Use repetitive text
  - Encourage prosodic variation
  - Provide opportunities to strengthen flexibility and reliability of the speech motor planning system (flip books)

136
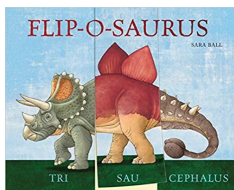
137

Fun and effective books for addressing prosody

138

17. Use real objects to represent speech targets

- Child-led, play-based therapy is easier when toys are available.
- Pair real objects with visual cue cards, books, and songs to make talking tasks more relevant and meaningful.

Pair the Silly Sounds cards with books and toys to make learning to talk fun and meaningful

139

Moo, Baa, La La La book and 3 Silly Sounds cards

Crocodile Dentist game paired with the "Ow!" Silly Sounds card

The "oooh!" Silly Sounds card pairs with anything pretty!

140

Color matching with silicone baking cups

Tiny Toys

141

Use 2.5 gallon Hefty Sliders to create sound and syllable bags to support speech motor planning skills during child-led play

142

Syllable Bag

Reduplication Syllable Bag Using Real Objects

Ba-ba, Beep-beep, Neigh-neigh, Choo-choo, Papa, Moo moo, Boo-boo, Ho-ho

143

Syllable Bag

CVCV Syllable Bag Using Real Objects

Pony – Potty – Minnie – Monkey – Woody – Dino – Table – Hippo
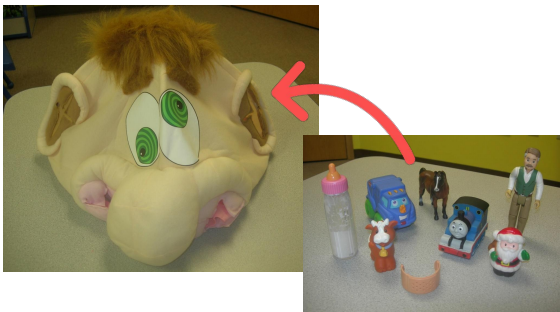
144

Sound Bag

Vowel Sound Bag Using Real Objects
"oo"

shoe – boo – Blue – moo – Pooh – glue –
choo choo – two- boo boo – blue – roo

145

Put objects from the sound/syllable bag inside Ned's Head


146

18. Elicit multiple repetitions of target words (without drill work!)

- Focus on repetitive speech practice through child-led, adult-guided play.

- Prioritize meaningful repetitions of speech targets rather than non-functional drill work.

- SLPs can elicit multiple repetitions by creating engaging activities with *multiple, identical pieces* (the number of identical pieces = the potential number of repetitions).

147

Activities for Eliciting Multiple Repetitions

➔ Use Velcro play food saying "cut" each time the child cuts with the toy knife
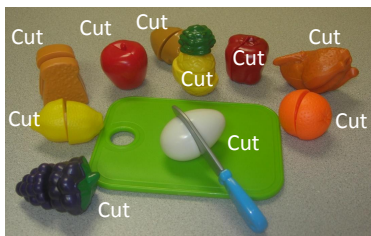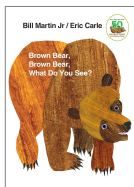

148

➔ Use a muffin tin + 12 identical objects to elicit 12 repetitions of the target word.

149

➔ Use predictable books with repeating phrases and have the child fill in the same word each time. For example, "Brown bear, brown bear what do you _____? I see a purple cat looking at _____."

➔ Use puzzles or other toys that contain identical pieces (such as a puzzle with lots of mommy animals and lots of baby animal).

150

➔ When looking at counting picture books, touch objects on the page repeating the object name instead of rote counting "1-2-3-4-5."
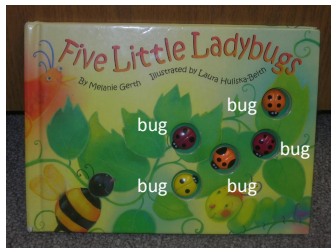
151

➔ Make boo-boo art by sticking band-aids on paper saying "boo-boo" each time.

➔ Have toy animals walk, eat, and sleep repeating key words "walk-walk-walk, eat-eat-eat, night-night."
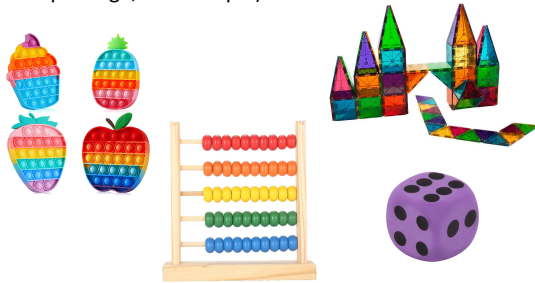

152

➔ Play with anything that pops (bubbles, foam ball poppers, rubber poppers).


153

→ Use an abacus, die, or pop-it toy to elicit multiple repetitions.

→ Use connecting toys, such as Lego's, marble runs, or Magna Tiles to get repetitive speech practice (5 reps per Lego, for example) .

154

→ Say "bye-bye" repeatedly as you put blocks into a tub or say "night-night" repeatedly as you put dollhouse figures to bed.

→ Look for games with multiple identical pieces, such as Mighty Monkey Pegs, Connect Four and Pop-Up Pirate. Have the child say the specified target word each time a piece is placed.
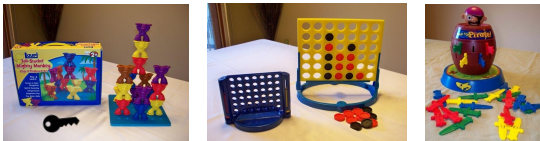
155

19. Establish accurate vowel sounds

- It is common for kids with apraxia to have vowel distortions, so be sure to address syllable shapes with with vowel differentiation.

- We want "bay-bee-buy-bo-boo" not just "/b/."

- Vowels shape the oral cavity and strongly affect intelligibility.

- Consider facilitative contexts and coarticulation when focusing on vowels (think about your mouth position when saying *coat* vs. *key*).
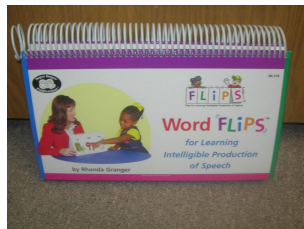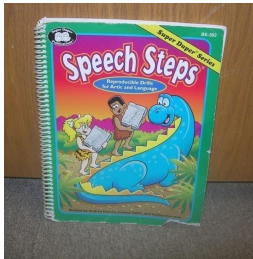
156

Strategies and activities for vowels

- Do not inadvertently reinforce overuse of the neutral vowel (ex: "bu-bu-ball or "du-du-down"); say the vowel sound before the word to establish the correct oral shape (ex: "ow - down" or "oo - boot")
- Begin shaping single word approximations with consonants and vowels that the child has success with
- Use *Speech Steps* and *Word Flips* that focus on consonant-vowel combinations
- Play with the *Vowel Owls Sorting Set*
- Introduce Cari's *Animal Vowels* and her Boom Cards that focus on establishing simple syllable shapes
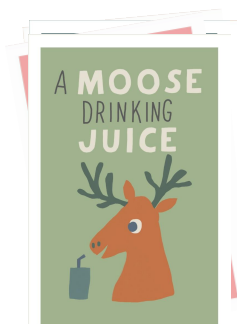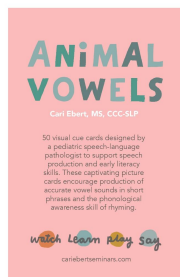
157

Speech Steps and Word Flips
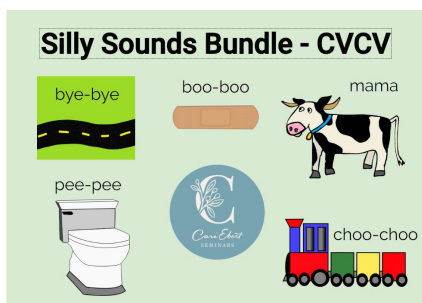

158

Vowel Owls Sorting Set
by Learning Resources

159

Cari's Animal Vowels

ANIMAL VOWELS

Cari Ebert, MS, CCC-SLP

50 visual cue cards designed by a pediatric speech-language pathologist to support speech production and early literacy skills. These captivating picture cards encourage production of accurate vowel sounds in short phrases and the phonological awareness skill of rhyming.

watch learn play say

cariebertseminars.com

A MOOSE DRINKING JUICE

Cari Ebert Seminars' Store on wow.boomlearning.com

Silly Sounds Bundle - CVCV

bye-bye

boo-boo

mama

pee-pee

choo-choo

Boom Card for CVCV Reduplication

Silly Sounds for New Talkers

BOO-BOO

Repeat "**boo-boo**" after placing each bandage on the animal

Boom Card for $C_1V_1C_2V_2$ Syllable Shape

On Monday, Danny the Dino went for a walk.
(have Danny walk across the screen)

boom-boom-boom
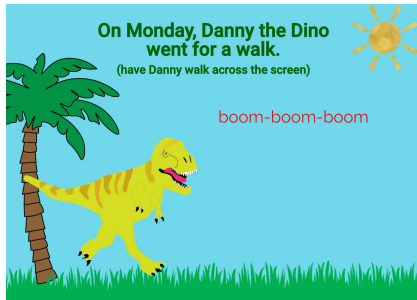
163

---

20. Expand syllable and word shapes

We need to focus on establishing more complex syllable and word shapes using the segments of speech (consonants and vowels) to improve the child's speech motor planning skills.

CV   CVCV   VC   CVC

CCVCC   CCVC   CVCVC

            VCVCC

164

Systematically increase complexity of the word shape:

- Reduplicated utterances (mama, dada, papa, wawa)
- 1 syllable words (go, no, eat, up)
- Two syllable words with same consonant and variable vowels (puppy, baby, daddy, mommy)
- Two syllable words with variable consonants and vowels (monkey, happy, dino, hippo, potty)
- Three syllable words and phrases (banana, potato, apple pie)
- Functional 4+ syllable words (watermelon, helicopter)
- Simple phrases (bye bye mama = CV.CV.CVCV)

165

Because of coarticulation, we don't have to select rarely used multisyllabic target words such as *celebration*, c*ertificate*, or *transportation*

Non-functional multisyllabic target word:

Kaleidoscope
CVCVCVCCVC

Functional, multisyllabic phrase:
"Play with Lego's"
CCV.CVC.CVCVC

166

21. Use target word therapy to establish a functional vocabulary

- Select individualized high-frequency target words (as opposed to random words from commercialized speech therapy products) to make talking more powerful for the child.
- Understand that the target words will not be the same for each child.
- Focus on about 5 speech targets at a time. For older kids, you can work on a few more. We want fewer targets with more reps!

167

- Encourage parents and teachers to assist with the target word selection by creating a WISH LIST of words and phrases.
- The SLP will select the target words/phrases from the WISH LIST. Target words will be selected based on the child's current phonetic inventory, preferred syllable shapes (e.g., CV, CVC), and how functional they are.
- Start with meaningful words such as the child's own name as well as names of family, pets, and friends, favorite foods, favorite toys, and other powerful words (e.g., *no*, *mine*, *help*).

168

- For children who are in the educational setting, be sure to consider target words from the curriculum and classroom activities.
- Teach the child how to produce these target words during the speech therapy session by focusing on the movement patterns; then coach parents and teachers on how to use cues to elicit these target words so practice can occur at home and in the classroom as well.
- Post target words in a prominent location at home or in the classroom, so all communication partners know which words are currently being addressed.

169

Hang a list of the target words on the wall or fridge at home; give the teacher a list of target words on a sticky note
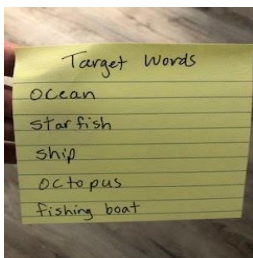
170

Don't forget about verbs…

We tend to focus on names, core words, and nouns, but verbs are necessary too

171

In Conclusion…

- Children with CAS need to have specific motor speech goals that address the core impairment (which is difficulty moving between sounds, syllables, and words).

- Because CAS rarely occurs in isolation, there will need to be other goals addressing the co-occurring issues.

- Children with speech motor planning struggles can and do make progress…when treatment is based on the principles of motor learning.

172

References

American Speech-Language-Hearing Association. (2007). *Childhood apraxia of speech [Technical report].*

Edeal, D. M., & Gildersleeve-Neumann, C. E. (2011). The importance of production frequency in therapy for childhood apraxia of speech. *American Journal of Speech-Language Pathology, 20*(2), 95–110.

Iuzzini-Seigel, J. (2019). *Motor Performance in Children with Childhood Apraxia of Speech and Speech Sound Disorders. Journal of Speech, Language, and Hearing Research, 62*(9), 3220-3233.

Iuzzini-Seigel, J., Moorer, L., & Tamplain, P. (2022). *An Investigation of Developmental Coordination Disorder Characteristics in Children With Childhood Apraxia of Speech. Language, Speech, and Hearing Services in Schools, 53*(4), 1006-1021.

173

Maas, E., Robin, D. A., Hula, S. N., Freedman, S. E., Wulf, G., Ballard, K. J., & Schmidt, R. A. (2008). *Principles of motor learning in treatment of motor speech disorders.* American Journal of Speech-Language Pathology, 17(3), 277–298.

McCabe, P., Beiting, M., Hitchcock, E. R., et al. (2024). Research Priorities for Childhood Apraxia of Speech: A Long View. *JSLHR*, 67(9S), 3255-3268.

Moore, J., Boyle, J., & Namasivayam, A. K. (2024). *Neurodiversity-Affirming Motor Speech Intervention for Autistic Individuals with Co-Existing Childhood Apraxia of Speech: A Tutorial. International Journal of Autism & Related Disabilities*, 7(1), Article 168.

Simonyan, K., Ackermann, H., Chang, E. F., & Greenlee, J. D. (2016). *New developments in understanding the complexity of human speech production.* Journal of Neuroscience, 36(45), 11440–11448.

174

Simonyan, K., Ackermann, H., Chang, E. F., & Greenlee, J. D. (2016). *New developments in understanding the complexity of human speech production.* Journal of Neuroscience, 36(45), 11440–11448.

Strand, E. A. (2020). Dynamic Temporal and Tactile Cueing: A Treatment Strategy for Childhood Apraxia of Speech. *American Journal of Speech-Language Pathology, 29*(1S), 30–48.

Viscomi, C. (2021, May 14). *7 Approaches for Childhood Apraxia of Speech. The ASHA Leader*.