Differential Diagnosis of CAS, Dysarthria, and Phonological Disorder

- Practical EBP Assessment Strategies

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- Power Up Conference December, 2021

Disclosures

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  - Member, Professional Advisory Council of Apraxia Kids

Objectives

1. Discuss use of ICF-CY Framework to support assessment planning

2. Review general assessment considerations for children with SSDs

3. Identify specific tools and tasks for differential diagnosis of phonological disorder, CAS, and dysarthria

4. Analyze assessment information to support diagnostic decisions

A Model to Consider

Cognitive processing

- **Internal message**
- **intent**

Memory
Attention
Perception

Linguistic processing

- **Phonological representations**
- **Word retrieval**
- **Grammar/syntax framing**
- **Phonologic mapping**

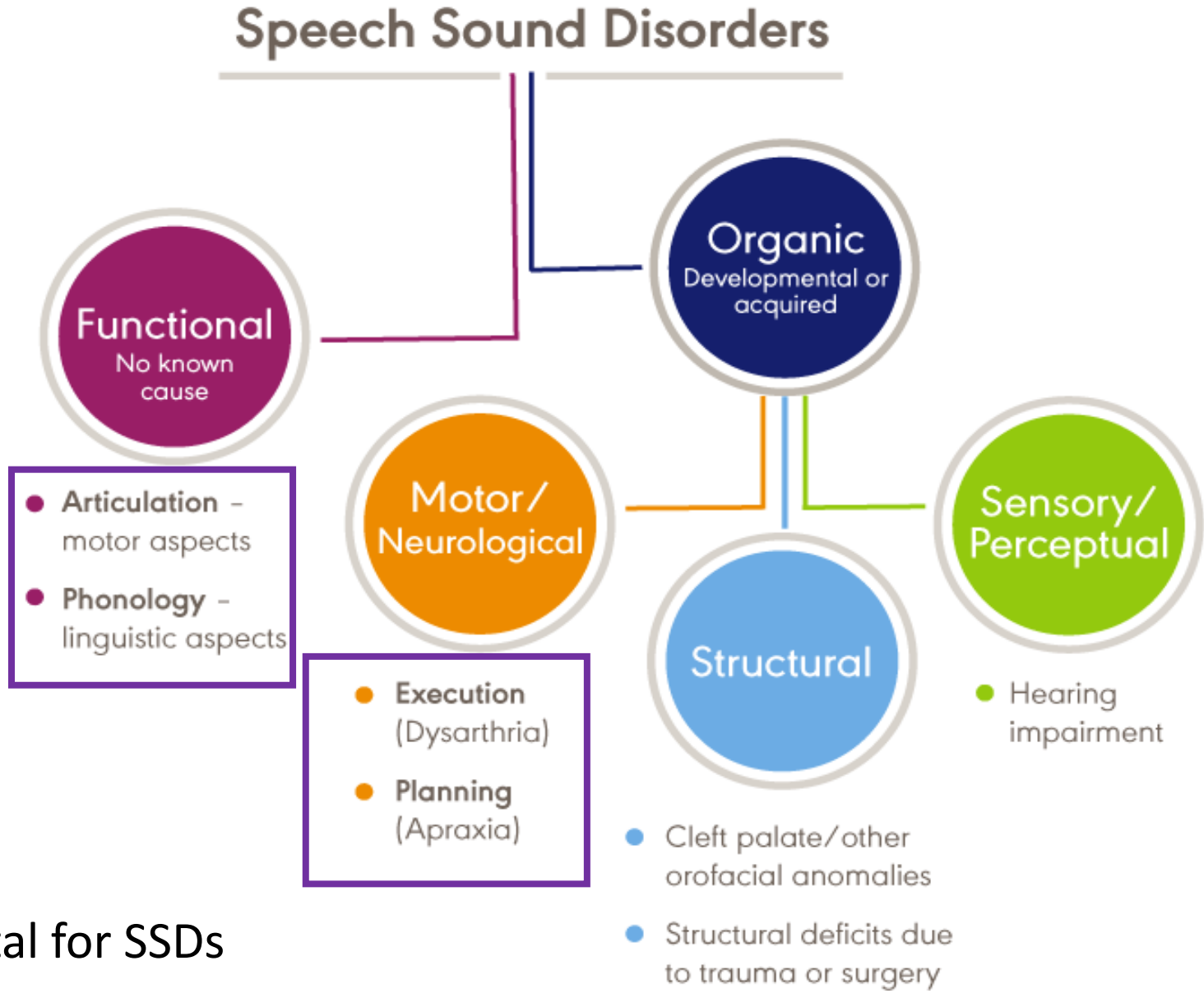
Store/retrieve information
Formulation

Motor processing

- **Sensorimotor planning/acoustic and spatial**
  - **Movement parameters**
- **Sensorimotor programming**
- **Execution of movement**

} Apraxia

} Articulation, Dysarthria



ASHA Practice Portal for SSDs

Speech Sound Disorders (SSDs)

Phonologic Disorder: cognitive-linguistic; pattern-based errors

Inconsistent Speech Disorder: phonological assembly difficulty without accompanying oromotor difficulties

Articulation Disorder: difficulty with physical production, typically distortions

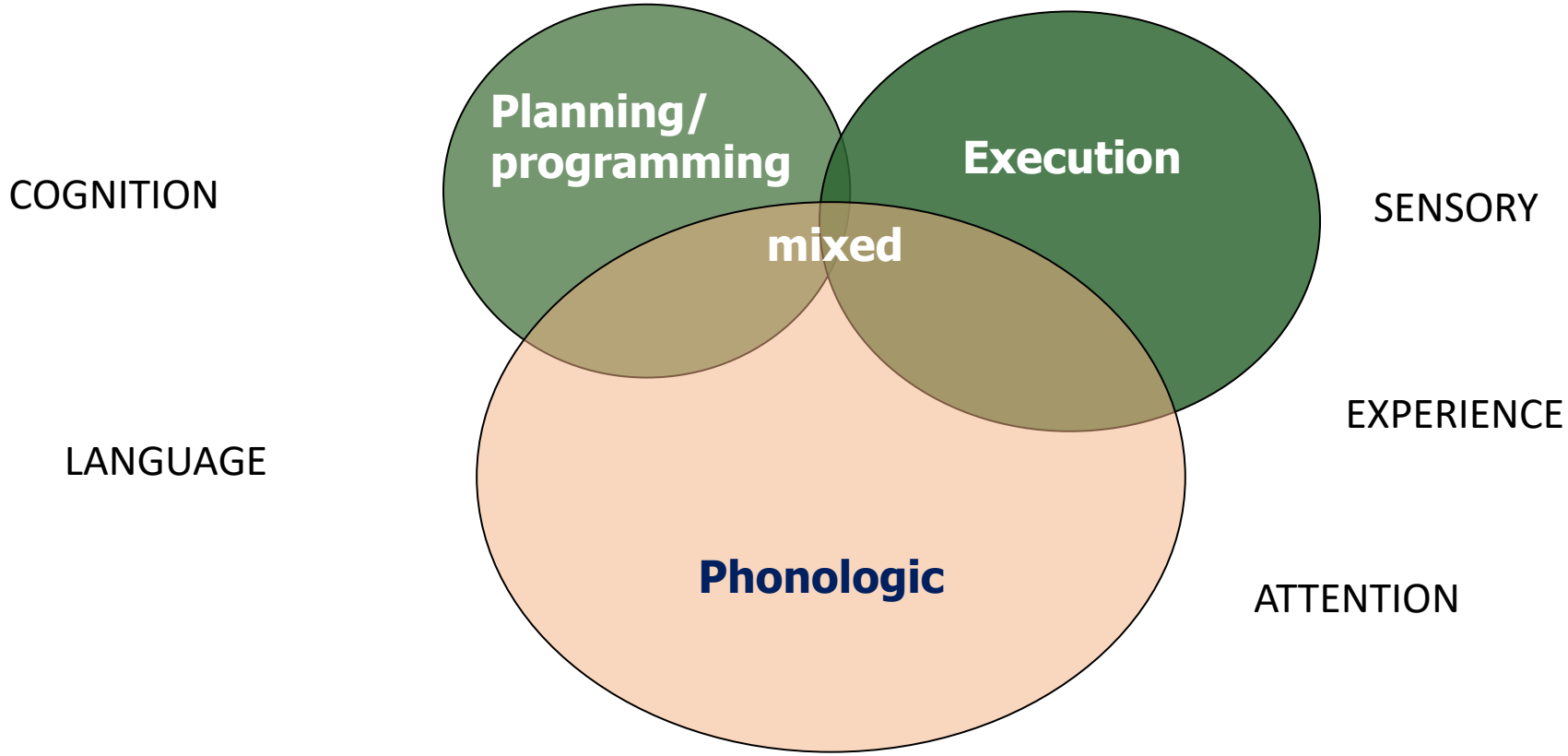
Childhood Dysarthria: difficulty with sensorimotor control for speech

Childhood Apraxia of Speech: difficulty planning and programming movement sequences

McLeod & Baker (2017). *Children's Speech: An Evidence-Based Approach to Assessment and Intervention*

Differentiating Severe Childhood Speech Sound Disorders

Simple, right?



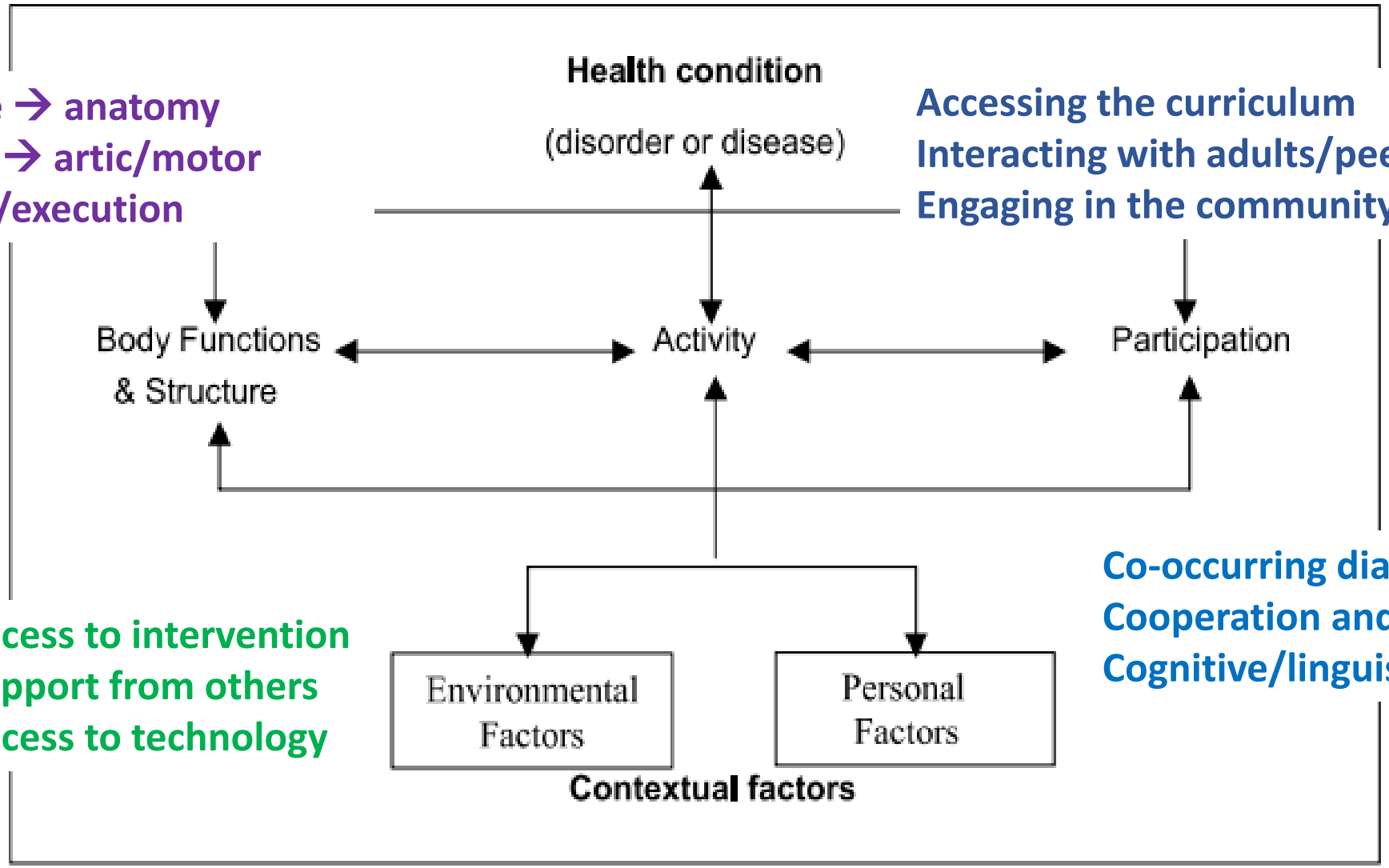
Challenges

- Expectations vary by developmental level
  - Some speech sound errors and phonologic patterns are typical for younger children
  - There is variability among children in when patterns are suppressed or when articulatory accuracy is achieved
- Children with delayed language or severe SSD may not provide enough information upon initial assessment to make a confident determination

Assessment Goals

- Rule in/Rule out SSD or establish need for further assessment/monitoring
- Determine the *relative contribution* of
    - cognition
    - linguistic (phonology and language) skill
    - speech motor skill
- Use assessment information to plan intervention if needed

WHO – ICF (World Health Organization, 2002)



Structure → anatomy
Function → artic/motor planning/execution

Accessing the curriculum
Interacting with adults/peers
Engaging in the community

Access to intervention
Support from others
Access to technology

Co-occurring diagnoses
Cooperation and motivation
Cognitive/linguistic abilities

Assessment

- History
- Oral structure and function
- Language screening/evaluation
- Analysis of speech production
  - Phonetic inventory
  - Error inventory – phonotactic/contextual factors?
    - Phonological patterns
    - Articulatory distortions
  - Prosody and Intelligibility
  - Motor Speech assessment
- Speech perception/Phonological awareness

History

- Physical structure and function (body functions and structure)
  - Physical structures, speech motor development, hearing
  - Intelligibility
- Parent/Caregiver & child concerns and goals (activities and participation)
- Developmental concerns, health conditions (personal factors)
  - Co-occurring conditions and issues
  - Attention/Motivation
- Prior intervention, resources (environmental factors)

Relevant History Might Include:

- **Phonologic disorder** → delayed acquisition of phonemes
- **CAS** →limited babbling/significantly reduced sound inventory
- **Dysarthria** → general delays in motor development/neurologic diagnosis, drooling, feeding difficulties

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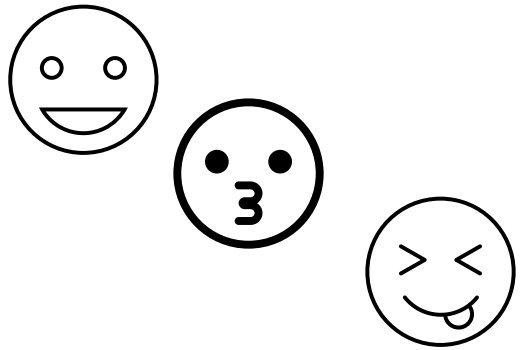
Oral Structure and Function

- Structures
  - Range of motion
  - Coordination
  - Strength
  - Ability to vary muscular tension
  - Speed
- Tissue characteristics
- Speech subsystems
  - Note voice quality, articulation, resonance, respiration, and prosody



Oral Structure & Function

- There appears to be a strong association between lip and jaw movements and measures of cognition and language
  - maintained even when accounting for age (Nip, Green, & Marx 2010)

- A wide range of variability was found among typical speakers -- from children to adults -- in an alternating tongue lateralization task (Small, McAllister, & Grigos, 2018)

Oral Structure & Function

Hypotonia ≠ weakness

- Hypotonia: reduced muscle activation *at rest* (not during speech)
- Weakness: reduced strength
  - Strength: muscle contraction, causing *movement* of a structure (e.g. during speech)

- Tongue strength was not related to severity of speech sound disorders for motor speech or SSD (Potter, Nievergelt, & VanDam, 2019)

Oral Structure & Function

A child with sufficient strength for speech will

- Produce plosive consonants adequately
- Have no nasal resonance
- Have good respiratory support and volume

Oral Structure & Function

Phonologic Disorder → normal structure & function

CAS →normal structures, may or may not observe nonverbal oral apraxia

Dysarthria → drooling; reduced speed of movement, range of motion, strength of movements

Take-Home Message Structure & Function

Consider the child's developmental level when assessing early nonspeech/speech motor skills

Assessment of muscles in action is required to establish presence or absence of weakness

Make observations of articulator function, but be wary of overinterpretation

Assessment

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Why Start with Language?

- There are interactions among cognitive, linguistic, and motor aspects of development
  - which change over time (Edwards, Munson & Beckman 2011; Nip, Green, & Marx, 2010; Smith & Goffman, 2004;)
  - Does the child exhibit communicative intent?
  - Is speech sound development generally commensurate with estimated language level?
    - Are there other issues (e.g., ASD) influencing communication?
  - Does nonverbal communication exceed verbal communication?

Language

- Language Sampling can be done with children who have limited intelligibility (Bingner, Ragsdale & Bustos, 2016)
  - Mean Length of Utterance in words
  - Mean number of syllables per utterance
  - Percentage of comprehensible words

Language

Phonologic Disorder → language may be WNL, but there may be co-occurring language delay (e.g., Shriberg et al, 1999; Sices et al., 2007)

CAS → delay in receptive language highly likely; diagnosis does NOT require a receptive-expressive discrepancy, but studies suggest the likelihood of unbalanced skills (e.g., McNeill & Gillon, Murray, Thomas, & McKechnie, 2019)

Dysarthria --> high likelihood of delays in receptive and expressive language, given frequent association with other neurologic diagnoses (e.g., CP, Down Syndrome)

Assessment

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Analysis of Speech

- Sound system analysis is needed
  - To describe the current phonetic/phonotactic inventory, including vowels
  - To analyze error patterns, identify distortions, look for consistency/inconsistencies
  - To guide decisions regarding intervention approach and stimulus selection
  - To establish a baseline for progress monitoring

- Brush up those transcription skills!

Analysis of Speech

- Single word tasks may provide a more complete picture, since all phonemes are sampled (Yeh & Liu, 2021)

However……

- Single word tests are not sufficient for completely documenting consonant and vowel inventory and selecting targets for therapy (Eisenberg & Hitchcock 2010)
- Criterion-referenced procedures and using standardized tests in nonstandard ways can contribute helpful information about a child's speech skills (Fabiano-Smith, 2019)
- Varied task complexity is important (Iuzzini-Seigel, et al., 2017; Murray, et al., 2015; Strand, et al., 2013)

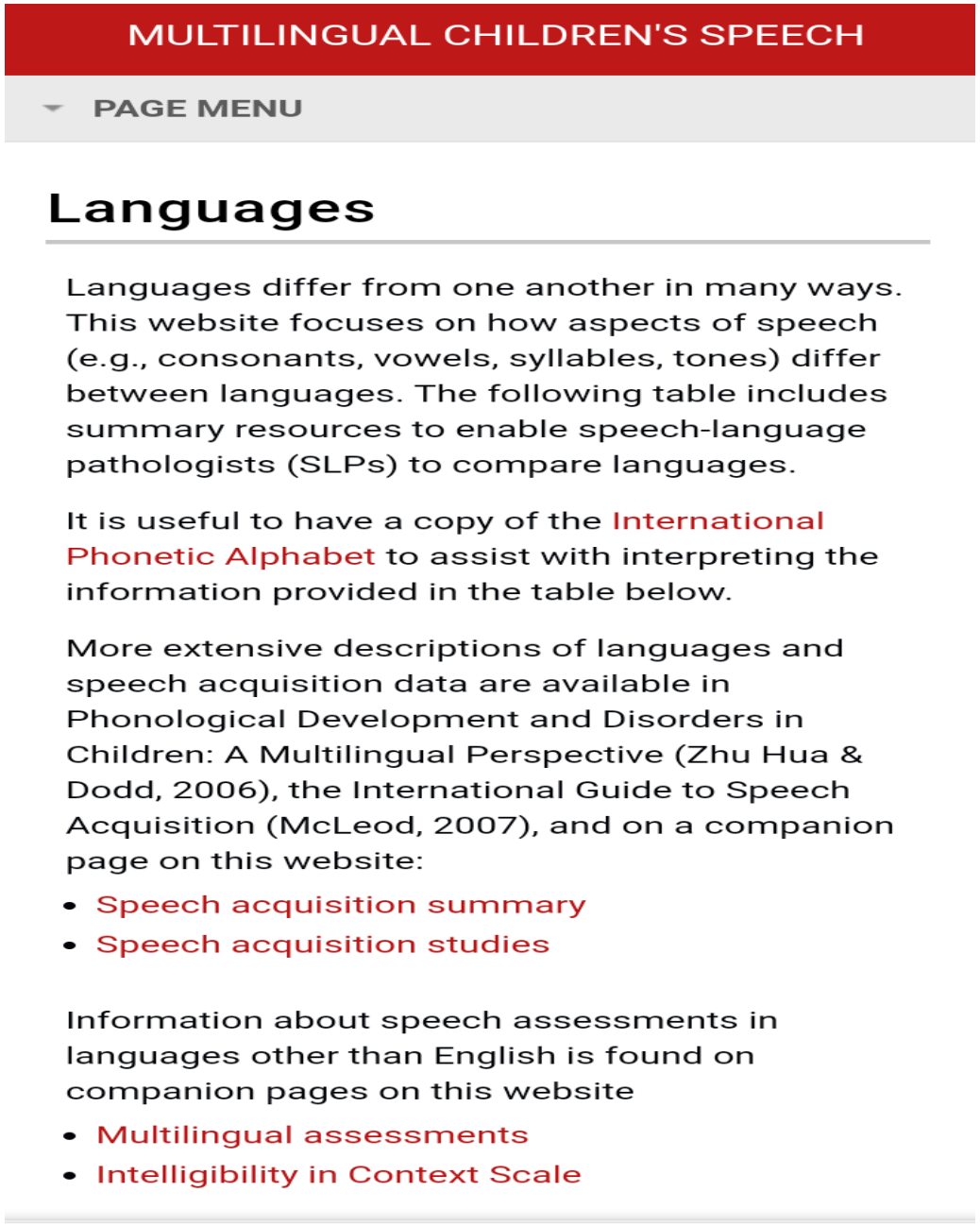
Analysis of Speech: Examples of Single Word Elicitation Tasks (English-Speaking Children)

- Arizona-4
- Diagnostic Evaluation of Articulation and Phonology (DEAP)
- Clinical Assessment of Articulation and Phonology (CAAP-2)
- Goldman-Fristoe Test of Articulation (GFTA-3)
- Hodson Assessment of Phonological Patterns (HAPP-3)
- Photo Articulation Test (PAT-3)
- SPAT-D-III

Assessment of vowels varies among these measures

Assessment of Multilingual Children

- Resource for multiple languages at Charles Sturt University website
- https://www.csu.edu.au/research/multilingual-speech

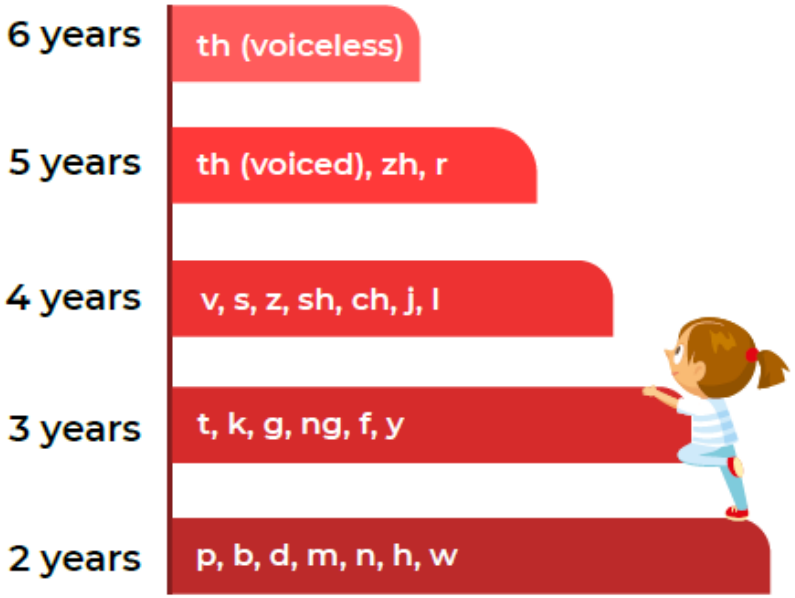


Assessment of Multilingual Children

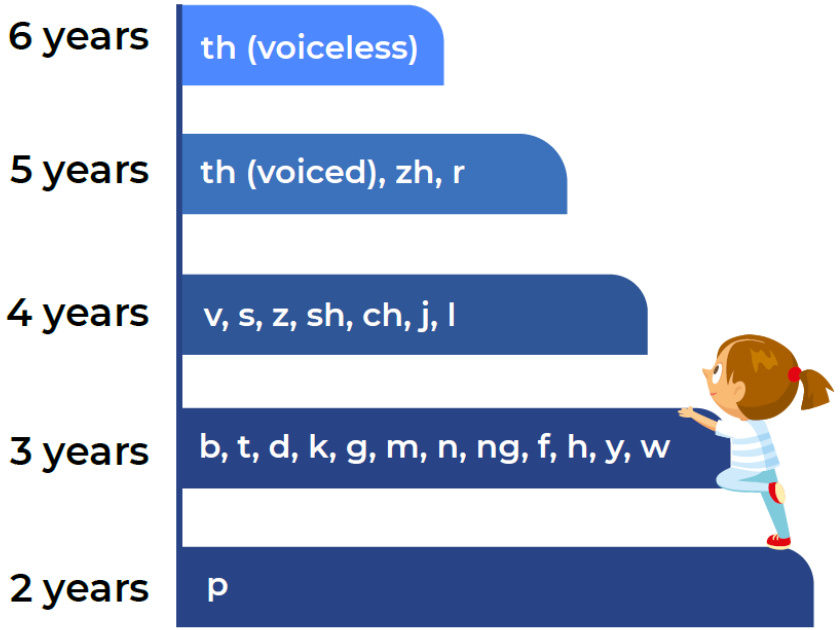
Open Access

- McLeod, S., Verdon, S., & International Expert Panel on Multilingual Children's Speech. (2017). Tutorial: Speech assessment for multilingual children who do not speak the same language(s) as the speech-language pathologist. *American Journal of Speech-Language Pathology, 26*(3), 691–708. https://doi.org/10.1044/2017_AJSLP-15-0161

Learning English Consonants (United States)



Learning English Consonants (Across the World)



Open Access articles listed in References

Analysis of Speech:

Remember that…

✓"Acquisition" can be defined with varied criteria and occurs gradually

✓The charts for developmental sequence were not intended to be used as eligibility benchmarks

✓Clinical decisions about intervention should be based on

- Information from multiple sources
- Understanding of the child – intrinsic factors

Analysis of Speech: Stimulability

- Stimulability testing helps determine
- how well a child can imitate a sound or sequence with help, which facilitates consideration of
  - whether it is likely to be acquired without intervention

(Glaspey & Stoel-Gammon, Tyler & Tolbert, 2002)

Types of Cues **Contexts**	Spontaneous production, or production in response to verbal model	Instructions given, with verbal model	Instructions given, with verbal model and slowed rate	Instructions given, with verbal model, slowed rate and tactile/gestural cues
Consistent accuracy in multiple settings with multiple partners	1			
Consistent accuracy in structured games or conversational practice	2	3		
Accurate in 3- or 4-syllable sequences	4	5		
Accurate in 2-syllable sequences	6	7	8	9
Accurate in simple (CV,VC, CVC) syllables	10	11	12	13
Not stimulable				14

Adaptation of the Glaspey Dynamic Assessment of Phonology Grid (GDAP, 2007), By Ruth Stoeckel, 2021

Intelligibility

- There are two primary approaches:
- Word-identification approaches
  - unfamiliar listeners transcribe what they think the child said
  - Good for tracking progress in therapy, but time-consuming
- Scaled ratings
  - global judgments of intelligibility on a numeric scale
    - Useful when the goal is to obtain a general measure of severity or for children who are unable to participate in structured testing.

Analysis of Speech: Intelligibility

Rating Scales

- Intelligibility in Context Scale (ICS) (Multiple languages)
- Speech Intelligibility Scale (Allen et al., 2001)

Single Word Measures

- Children's Speech Intelligiblity Measure (CSIM) (1999)
- TOCS+ (2009)

Connected Speech Measures

- Beginners Intelligibility Test (BIT) (1994)
- Conversational Intelligibility (Flipsen, 2006b)
- Shriberg, et al. (1997a,b)

Analysis of Speech: Prosody

- Evaluating aspects such as
  - Phrasing/respiratory support
  - Rate
    - Slowed/pauses, accelerated, inconsistent
  - Lexical and sentential stress marking
    - Equal/excess, reduced, excessive, misplaced

Analysis of Speech: Prosody

- Measures include
  - Prosody Voice Screening Profile (PVSP) (Shriberg, 1990)
  - Prosody Voice Profile (PVP) (Shriberg, 2003)
  - Profiling Elements of Prosody (PEP-C) (Peppe & McCann 2003a & Peppe 2015)

Feature	Typical	Atypical
Phrasing		
Rate		
Lexical Stress		
Sentential Stress		
Loudness		
Pitch		
Pitch Variation		

Prosody Screening

Analysis of Speech

Phonologic Disorder → some delay in acquisition of phonemes; identifiable patterns of error; normal prosody

Inconsistent Phonological Disorder → less consistent patterns of error without obvious motor impairment

CAS → reduced sound inventory; inconsistent errors; vowel errors; disrupted prosody

Dysarthria → imprecision in speech sound production; slow rate; speaking in small breath groups

Assessment

- History
- Oral structure and function
- Language screening/evaluation
- Analysis of speech
  - Phonetic inventory
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Motor Speech Skill

- No single test is fully adequate to assess motor speech skill (McCauley & Strand, 2008)
  - A checklist approach to assessment is insufficient
  - Characteristics and how they are expressed will vary with developmental level, response to therapy, etc.

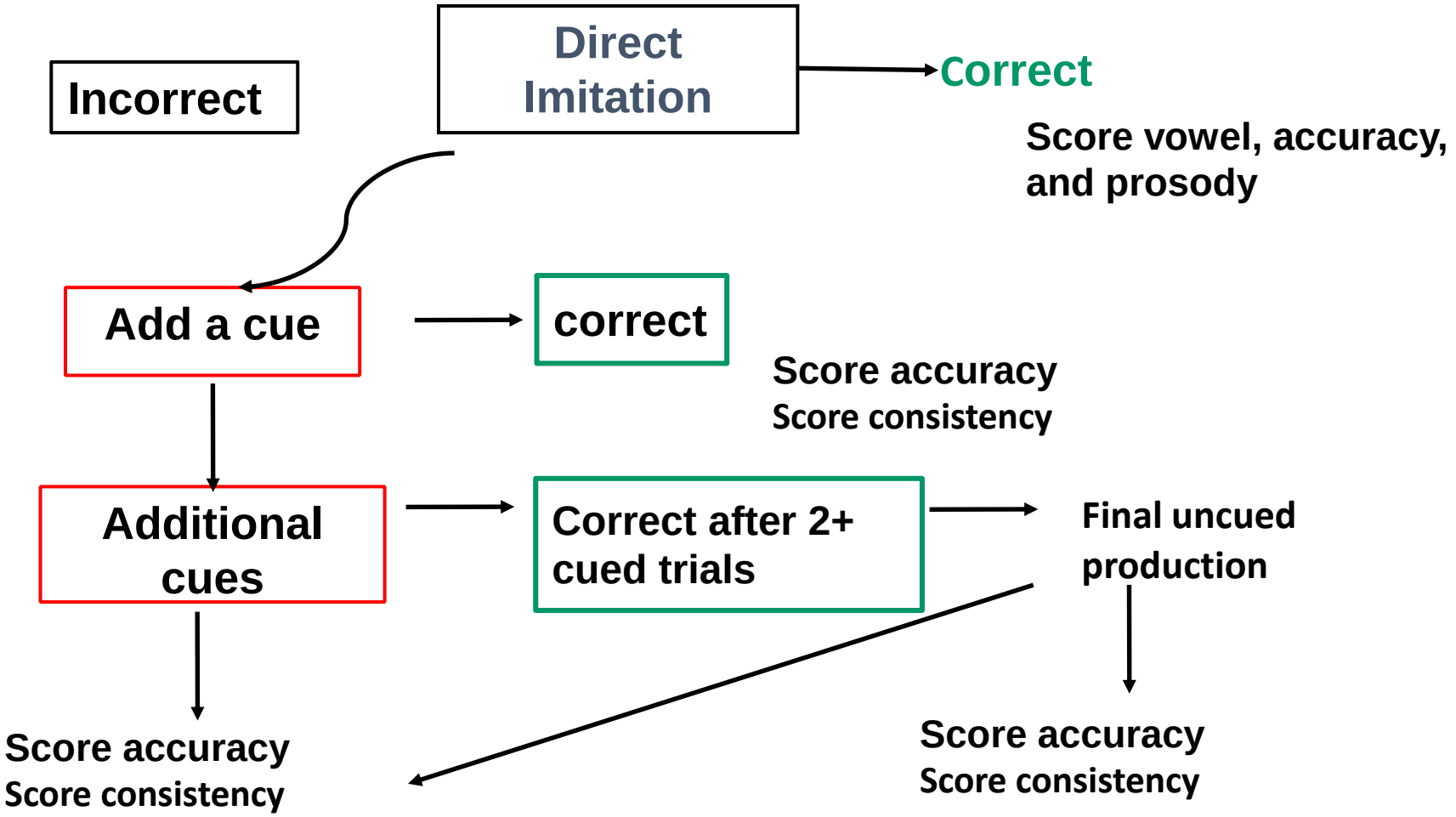
- "A comprehensive oral mechanism examination includes a **motor speech assessment.** This is critical for differentiating CAS from childhood dysarthria and other speech sound disorders" ASHA Practice Portal for CAS

Motor Speech Skill

Some measures that have been used clinically and in research include:

- Dynamic Evaluation of Motor Speech Skill (Strand & McCauley, 2019)
- Multisyllable Word Repetition (e.g., Benway & Preston, 2020; Masso, McLeod,& Baker, 2018, Murray et al., 2015)
- Maximum Performance Tasks (e.g., Diepeven et al., 2019; Rvachew et al., 2005, Thoonen et al., 1996, 1999)
- Pause Marker (Shriberg et al., 2017a Tilkens et al.,2017)
- Syllable Repetition Task (Rvachew & Matthews, 2017;Shriberg et al., 2012)

Dynamic Assessment/DEMSS



Inconsistency Severity Percentage (ISP)
(Iuzzini-Siegel)

- $\frac{\text{total number of different error types -1 for each phoneme}}{\text{Total \# of target singleton consonants}} \times 100 = \text{ISP}$

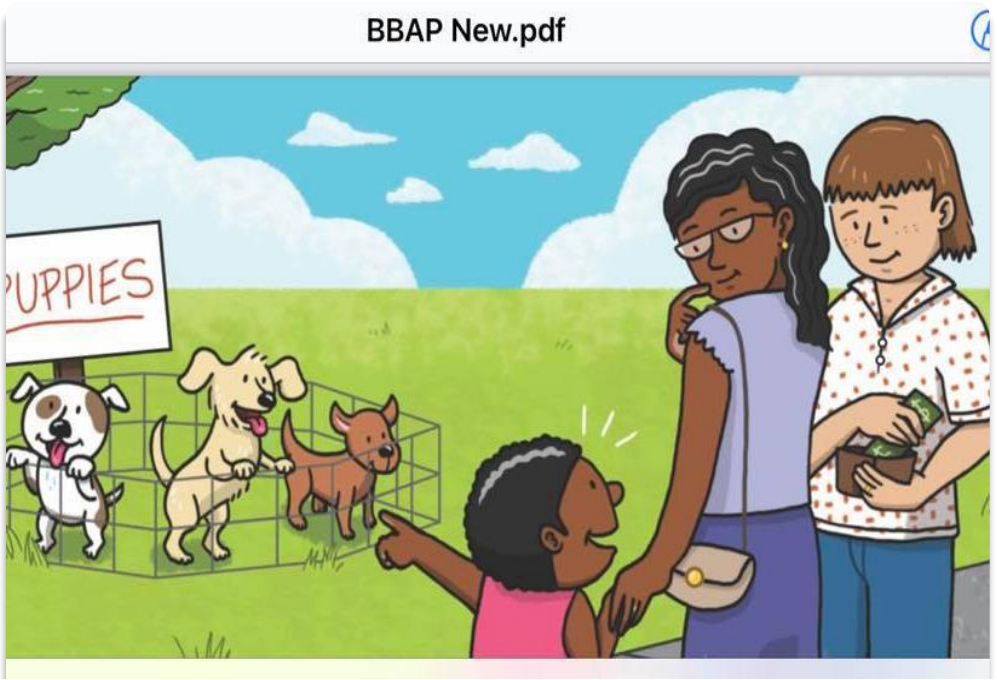
- ≥ 18% → Likely CAS
- 10% - 17% → likely Phonological
- < 10% → normal

- Useful for preschoolers

Motor Speech Skill Multisyllable Task
(Iuzzini-Siegel)

B**uy Bobby a Puppy**

For School-age children
*Children with LI also demonstrate Inconsistency on this task



https://campsite.bio/marquette_cml_lab

Polysyllable Task

Orthography	Adult model	Child's production
broccoli	brɒkəli	
escalator	ɛskəleɪrə	
umbrellas	ʌmbrɛləz	
computer	kəmpjurə	
spaghetti	spəgɛti	
ambulance	æmbjələns	

Motor Speech Skill
Maximum Performance Tasks (MPT)

- For 6+ years
- Maximum vowel and fricative durations
- DDK – AMR & SMR
- Criteria for Dysarthria vs. Apraxia
- Diagnostic accuracy – 95.2% (based on a small number of children)

Motor Speech Skill
Pause Marker (PM)

- For 3+ years
- The Type I “Pause Marker” provides a “single sign marker that likely can be used cross-linguistically to discriminate CAS from speech delay, and to scale the severity of CAS”
- Type I = atypical pause, abrupt, groping
- NOT Type II = more typical addition, repetition/revision. long, breath

Syllable Repetition Task (SRT)

- Intended for 3+ years
- Repeat 1-4 syllable nonsense syllables /n, b, d, m/ plus schwa
  - e.g.,bada, badana, manadana
- Count sound additions = transcoding score
- Cutoff <80% likely CAS
- Diagnostic Accuracy – 78.4%

Systematic Review/Evidence Summary
POSSIBLE protocol for younger child

(Murray et al, 2020, McCabe et al., 2020)

Dynamic Evaluation of Motor Speech Skill (DEMSS)

Iuzzini-Seigel inconsistency measure

Single word speech sound inventory (50 or more words with range of word shapes

And

Robbins & Klee oral musculature assessment

Polysyllable test

Or

Maximum Performance Tasks

Systematic Review/Evidence Summary: **POSSIBLE** protocol for older children

CAS vs SSD

(Oral musculature assessment)

Single word test with at least 30 polysyllables

Sample of connected speech

Pause Marker

and/or

Inconsistency measure

Systematic Review/Evidence Summary: **POSSIBLE** protocol for older children

CAS vs dysarthria

Thorough oral musculature assessment

Single word test with at least 30 polysyllables

Sample of connected speech

Polysyllable task

And

Maximum Performance Tasks

Assessment

- History
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Phonological Awareness/ Speech Perception

- Speech sound *perception* skills may be impaired in some children with speech sound disorders (Hearnshaw, Baker, & Munro 2019 meta-analysis)
  - On a measure of speech perception (syllable discrimination) children with CAS + LI or SD + LI showed poorer discrimination, with appreciable within-group variability (Iuzzini-Seigel et al., 2015; Zuk, et al., 2018)
- Formal tests include the CTOPP, TOPA, Wepman, etc.
- Informal measures include the Locke task (1980)

Date:		Date:	
Production Task / / –> / /		Production Task / / –> / /	
Target / / Error / / Control / /		Target / / Error / / Control / /	
Stimulus - Class	Response [2]	Stimulus - Class	Response [2]
1. / / - Control	yes - NO	1. / / - Target	YES - no
2. / / - Error	yes - NO	2. / / - Control	yes - NO
3. / / - Target	YES - no	3. / / - Target	YES - no
4. / / - Target	YES - no	4. / / - Control	yes - NO
5. / / - Error	yes - NO	5. / / - Error	yes - NO
6. / / - Control	yes - NO	6. / / - Error	yes - NO
7. / / - Control	yes - NO	7. / / - Target	YES - no
8. / / - Target	YES - no	8. / / - Error	yes - NO
9. / / - Error	yes - NO	9. / / - Target	YES - no
10. / / - Target	YES - no	10. / / - Control	yes - NO
11. / / - Error	yes - NO	11. / / - Control	yes - NO
12. / / - Control	yes - NO	12. / / - Error	yes - NO
13. / / - Error	yes - NO	13. / / - Target	YES - no
14. / / - Target	YES - no	14. / / - Control	yes - NO
15. / / - Control	yes - NO	15. / / - Error	yes - NO
16. / / - Error	yes - NO	16. / / - Target	YES - no
17. / / - Target	YES - no	17. / / - Error	yes - NO
18. / / - Control	yes - NO	18. / / - Control	yes - NO
Mistakes: Error ____ Control ____ Target____		Mistakes: Error ____ Control ____ Target____	

[1] Source: Locke, J. L. (1980). The inference of speech perception in the phonologically disordered child. Part II. Some clinically novel procedures, their use, some findings. *Journal of Speech and Hearing Disorders, 45 (4)*, 445-468.

Assessment Outcome

- Characteristics that are often present but may occur with any SSD:
  - Limited consonant and vowel repertoire
  - Use of simple syllable shapes
  - Frequent omission of sounds
  - Many errors, poor score on standardized measure of articulation/phonology
  - Poor intelligibility

Differentiating Characteristics

Phonological Disorder	Childhood Apraxia of Speech	Childhood Dysarthria
Consistent patterns of error	Token to token inconsistency	Consistent imprecision/distortions
No weakness	No weakness	Weakness
Some increase in errors with increased length/complexity	Notable increase in errors with increased length/complexity	Errors generally consistent with increased length/comlexity
Normal rate	Rate may be slowed	Rate may be noticeably slowed and/or inconsistent
No issues with respiration/phonation	No issues with respiration	Reduced breath group length
Typical voice quality	Typical voice quality	Atypical voice quality
Typical prosody	Disrupted prosody/sequencing	Difficulty regulating prosody/stress

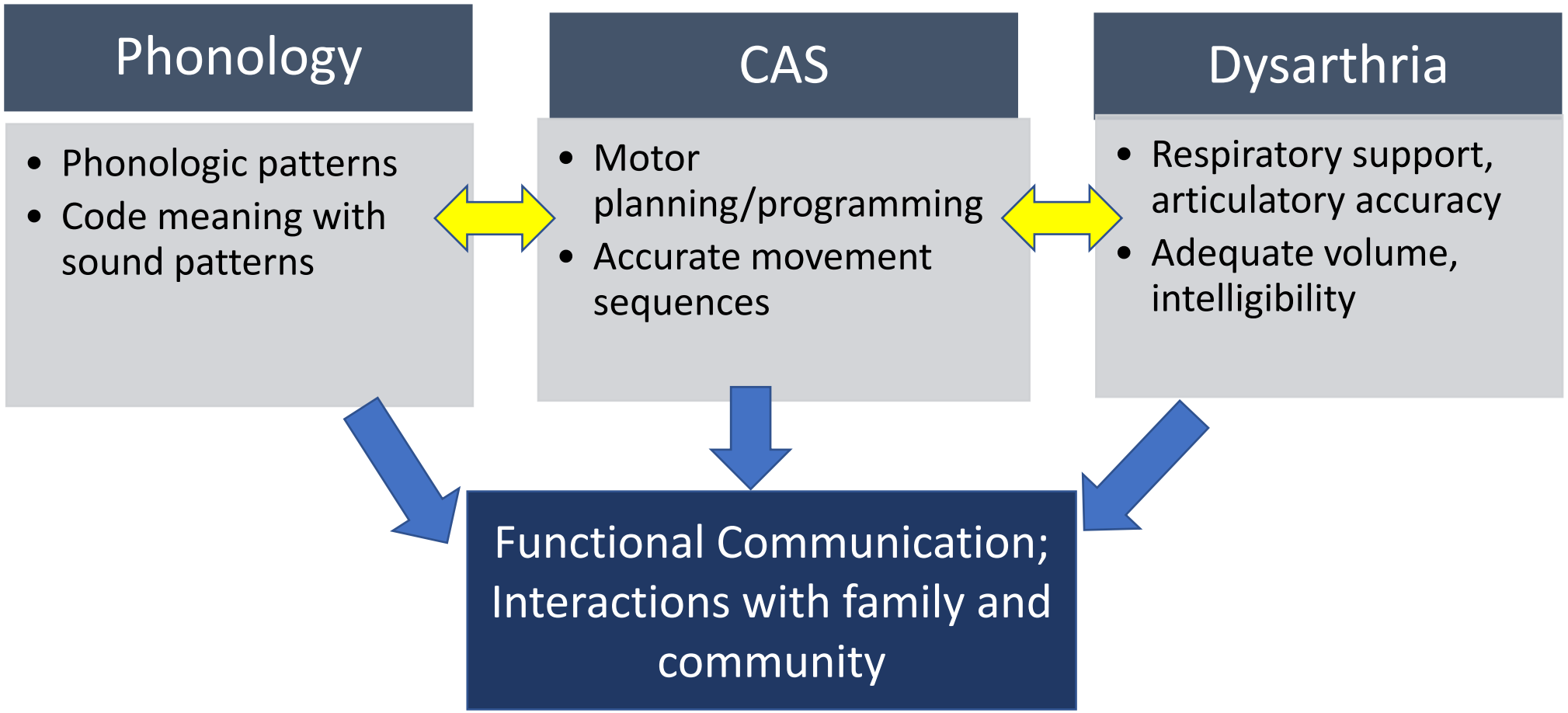
Take Home Message: Assessment

Collect information from a variety of measures

Different measures will be needed for children of different ages and abilities

Consider the WHOLE child (relative contribution, social needs) in making a diagnosis

Assessment Outcome: Planning Treatment



THANK YOU

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