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- **Financial Disclosures**
  - Employed (Assistant Professor and Director of Clinical Speech Language Pathology) by the University of Colorado at Boulder
  - The Speech Language and Hearing Clinic and MA-SLP students at the University of Colorado-Boulder are supported by funds from the Scottish Rite Foundation of Colorado

- **Non-Financial Disclosures**
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  - Member of Colorado Speech-Language Advisory Council for the Department of Education
  - Member of the ASHA and several SIG groups and the Sleep Research Society
  - Ad-hoc reviewer for several peer-reviewed journals
  - Appropriate releases obtained from caregivers for client information presented educational purposes today

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  - 2016 Recipient of a Dwight A. Hamilton Scottish Rite Foundation of Colorado Graduate Scholarship in Speech-Language Pathology
  - The Speech Language and Hearing Clinic and MA-SLP students at the University of Colorado-Boulder are supported by funds from the Scottish Rite Foundation of Colorado

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**Childhood Apraxia of Speech (CAS)**

"CAS is a disorder of speech motor control in which the motor planning and programming of speech movements is impaired in the absence of neuromuscular deficits (i.e., no clinical signs of muscular weakness or abnormal tone/reflexes)." (p. 2)

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**Current Theoretical Perspective**

It is hypothesized that the underlying impairment is in the ability to translate the "abstract phonological code" (Terband et al., 2009; p. 1598) into a speech motor command.

-- Murray, McCabe, & Ballard (2014)
**Causes of CAS**

- Neurodevelopmental/Neurobehavioral
  - Intrauterine causes
  - Metabolic disorders
- Genetic
  - FOXP2, FOXP1, FOXG1, CNTNAP2, ELP4, RAI1
  ~Shriberg et al., (2012)
- Idiopathic

**Speech Disorders Classification System – Typology**

Shriberg et al. (2010)

- Speech Delay
- Speech Errors
- MSDs

**Childhood SSD Phenotype**

(Carrigg et al., 2016)

- 38 – 62% expressive language impairment
- 6 – 21% receptive language impairment
- Phonological processing (phonological awareness, phonological memory, auditory discrimination, literacy difficulties) ~Blum, Peter; Stock-Garniron, A; Pearson, R; Shriberg, L; Lohmander, S; & Jakielski, S (2012)
- Fine and gross motor difficulties
- Lower oral-motor sequencing
- Rapid sound repetition abilities impaired
- Global deficit in sequential processing in motor, linguistic and cognitive domains
- Deficits in sensory processing ~Newmeyer et al. (2009)

**CAS Controversies**

- Especially challenging to differentiate CAS from other SSDs ~Carrigg, Perry, Baker, Shriberg, & Ballard (2016)
- Reliable and replicable methods unavailable → overdiagnosis ~Mattrey-Kott, Lohnsander, & McAllister (2016)
- “Evolving nature of clinical symptoms” (p. 2) ~Terband, Measam, Granther & Brumberg (2009)

**CAS Diagnostic Considerations: A Brief History**

- 2003
- 2006
- 2007
Issues related to establishing a core of critical characteristics of DAS have not changed significantly over the past 40 years” (p. 26)  
Davis, Jakielski, & Marquardt (1998)

- **2003**
  - Forrest (2003)
    - Is DAS (Developmental Apraxia of Speech) a distinct phenomenon?
    - Subset of general phonological disorders?
    - Motor disorder?
    - 75 SLPs listed 50 characteristics (some contradictory) total as signs that led to the diagnosis of DAS. The following 6 characteristics accounted for 51.5% of responses:
      - Inconsistent productions
      - Oral-motor deficits
      - Groping
      - Difficulty with sound imitation
      - Poorer performance with increased utterance length
      - Difficulty sequencing sounds

- **2003**
  - Shriberg et al. (2003)
    - diagnostic checklists – set of inclusionary criteria that may be sensitive but not specific
    "The central problem is that the array of items on such lists casts too wide a net – reminiscent of Guyette and Diedrich's (1981) widely cited critique that childhood apraxia of speech was a clinical entity in search of itself.” (p. 552)

- **2006**
  - Millspaugh & Weiss (2006)
    - Consensus was reached by 60% of SLPs and researchers on the following five characteristics of CAS
      - Inconsistent productions
      - Difficulty sequencing sounds
      - Groping
      - Articulation errors
      - Poor intelligibility

- **2007**
  - CAS as term of choice
  - Three features (2007):
    - Inconsistent errors on consonants and vowels in repeated productions
    - Lengthened and disrupted coarticulatory transitions
    - Inappropriate prosody
As of 2008......

- 61% SLPs still uncertain about differential diagnostic markers of CAS
  - Joffee & Pring (2008); Malmenholt et al. (2016)

**Assessments (through 2007)**
- Kaufman Speech Test for Children (KPST)
  - 2-5;11 years
- Verbal Motor Protocol Assessment (VMPAC)
  - 3-12 years
  - Closing out of print this year
- Diagnostic Evaluation of Articulation and Phonology (DEAP)
  - 3-8;11 years
- The Orofacial Praxis Test
  - 4-8 years
- The Madison Speech Assessment Protocol (MSAP; Shriberg et al., 2010)
  - Includes 25 tests/tasks (15 speech tasks), including:
    1. GFTA-2
    2. Vowel Tasks
    3. Conversational speech sample
    4. Lexical stress tasks
    5. Case History
    6. DDK rates
    7. Oral mechanism exam
    8. Syllable Repetition Task
    9. Multisyllabic Words Task

**Syllable Repetition Task**
(Shriberg et al., 2009)
- Use: children with mild to severe speech sound disorders
- 18-items, 5 minutes
- Requires mastery of only 5 of 42 phonemes
- Reveals deficits in auditory-perceptual encoding and memory

**Strand’s 10-point Checklist**
Shriberg et al. (2012)
- For a diagnosis of CAS, four (vowel distortions + 3 other) of the following must be noted on 3 or more MSAP tasks:
  1. Difficulty achieving initial articulatory configurations
  2. Syllable segregation
  3. Equal stress or lexical stress errors
  4. Vowel distortions/ Distorted substitutions
  5. Groping
  6. Intrusive schwa
  7. Voicing errors
  8. Slow rate
  9. Slow DDKs
  10. Disproportionate difficulty with multisyllabic word production

**The Madison Speech Assessment Protocol (MSAP; Shriberg et al., 2010)**
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  7. Oral mechanism exam
  8. Syllable Repetition Task
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**Dynamic Evaluation of Motor Speech Skill (DEMSS)**
- Strand et al. (2013)
- Development in progress
- 3 – 6 years
Murray, McCabe, Heard, & Ballard (2015)

- 91% diagnostic accuracy (prediction of expert diagnoses as CAS or non-CAS)

- Tasks (~30 minutes)
  - Thorough oral mechanism examination (with sequential motion rate assessment)

- Measures:
  - Syllable segregation
  - Percentage lexical stress matches
  - PPC
  - Accuracy on repetitions of “pataka”

2009 - 2016

- 17% attendees at a 2011 ASHA Convention course had read the position statement

“Still seeking consensus by way of identifying sensitive and specific tests...”

The current gold standard for diagnosis is expert opinion” (p. 43)

- Meredith & Potter (2011)

Gains in the objective assessments available for the differential diagnosis of CAS

Treatment Approaches

- Treatments include:
  - Motor Approaches
    - Integral Stimulation (Rosenbek et al., 1973)
    - Dynamic Temporal Tactile Cuing (DTTC; Strand, Stoeckel, & Baer, 2006)
    - Prompts for Restructuring Oral Muscular Phonetic Targets (PRONTO; Chompilekis, 1984)
    - Principles of Motor Learning
      - Rapid Syllable Transition (ReST)

  - Linguistic Approaches
    - Integrated PhonologicalAwareness
    - Minimal Pair Contrasts

  - Combination Approaches

  - AAC

Trends and Evidence in Treatment

Two Notable Updates

- Principles of Motor Learning
  - Namasivayam et al. (2010)
  - Skelton and Hagopian (2014)
  - Maas, Butalla, & Farinella (2012)

- Rapid Syllable Transition (ReST)
  - Murray, McCabe, & Ballard (2015)

Principles of Motor Learning

<table>
<thead>
<tr>
<th>Principle</th>
<th>Acquisition</th>
<th>Retention</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Schedule</td>
<td>Blocked</td>
<td>Random</td>
<td>e.g. “boy” ten times in a row</td>
</tr>
<tr>
<td>Practice Distribution</td>
<td>Mass</td>
<td>Distributed</td>
<td>e.g. One 60-minute session per week</td>
</tr>
<tr>
<td>Practice variability</td>
<td>Stable</td>
<td>Variable</td>
<td>Same context</td>
</tr>
<tr>
<td>Feedback Type</td>
<td>Knowledge of Results</td>
<td>Knowledge of Performance</td>
<td>e.g. “good”</td>
</tr>
<tr>
<td>Feedback Frequency</td>
<td>Frequent</td>
<td>Infrequent</td>
<td>e.g. alter every trial</td>
</tr>
</tbody>
</table>

Maas et al. (2008)
Rapid Syllable Transition (ReST)

- Applies principles of motor learning to target lexical stress
- Uses polysyllabic nonwords
- Each session is divided up into: pre-practice and practice portions
- Practice is intense (> 100 trials), variable, random, and feedback (knowledge of results) frequency is low
- 10 – 12 one-hour sessions
- Older children with moderate deficits

CAS in the Long-Term

- A persistent SSD requiring long-term treatment
- Speech errors resolve in many individuals
  
  (Lewis et al., 2016; Peterson, Pennington, Shriberg, & Boebe, 2006)
- Manifest as literacy, learning and academic difficulties
  
  (Lewis, Freedman, Horner, Iyengar, & Taylor, 2004)
  
  (Mornay & Gilson, 2006)

Summary

- The definition of CAS has not changed much in the past many years, and since ASHA’s 2007 position statement. There is increased evidence to support previously listed perceptual diagnostic criteria.
- Newer evidence continues to highlight variability and uncertainty, however, in consensus on perceptual characteristics specific to CAS criteria, and the need to replicate checklists and tools on wider populations has been emphasized in recent literature.
- Co-morbidity with phonological and other language impairments, fine and gross motor difficulties, processing deficits, and dysarthria continue to add to the challenge in differential diagnosis.
- There has been a need and a push to identify bio- and behavioral markers of CAS to aid objective, sensitive and specific differential diagnosis of CAS.
- While we have made strides in developing tools that may be more reliable and sensitive to CAS, these are not (quite yet!) a substitute for perceptual diagnosis of CAS by an experienced examiner.
- Treatments most effective for CAS incorporate the principles of motor learning, and cueing hierarchies in treatment.

References


Questions?

- ASHA Position Statement: http://www.asha.org/policy
- ASHA Practice Position Statement: http://www.asha.org/policy

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