Fine Motor, Oral Motor, & Speech Skills in Childhood
Apraxia of Speech

Allison Flynn, M.A. CFY-SLP;
Sandra Grether, Ph.D. CCC-SLP;
Erin Redle, Ph.D. CCC-SLP
Childhood apraxia of speech (CAS) is a controversial and greatly debated diagnosis

- Lack of understanding of the etiology and disagreement over core deficits
- Challenges in producing quality research (Morgan & Vogel, 2009)
- Oral motor and fine motor praxis deficits are reported in the literature (ASHA, 2007; Dewey, 1995; Maassen, 2002; Newmeyer et al., 2007); however not validated
- Undetermined role of relationships between oral motor, fine motor, and speech praxis
This study aims to provide evidence regarding the relationships among the oral-motor, fine-motor and speech skills of children with CAS.
Literature Review

• Overview of Etiology
• Overview of Terminology
• Diagnosis of CAS
• Speech vs Non-Speech Motor Controls
Formal Definition of CAS

“Childhood apraxia of speech is a neurological childhood (pediatric) 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). CAS may occur as a result of known neurological impairment in association with complex neurobehavioral disorders of known or unknown origin, or as an idiopathic neurogenic speech sound disorder. The core impairment in planning and/or programming spatio/temporal parameters of movement sequences results in errors in speech sound productions and prosody (p. 3-4).”

ASHA, 2007
Overview of Etiology

- Genetic
  - Variable phenotypes (ASHA, 2007)

- Neurological
  - Idiopathic
    - Motor speech theory (Ackermann & Riecker, 2004; Maassen, 2002; Nijland, Maassen, & van der Meulen, 2003; Riecker et al., 2000; Riecker, Brendel, Ziegler, Erb, & Ackermann, 2008; Riecker et al., 2005)
    - Domain specific
  - Global
    - Central timing deficit (Peter & Stoel-Gammon, 2005, 2008)
    - Domain general
Overview of Terminology

- **Idiopathic**
  - Developmental verbal dyspraxia; Developmental apraxia of speech
  - Isolated speech praxis deficits *(ASHA, 2007)*

- **Global**
  - Developmental dyspraxia; Developmental coordination disorder
  - Used to classify children with limb, orofacial, and verbal praxis deficits *(Dewey, 1995)*
CAS Diagnosis

- CAS lacks specific diagnostic criteria
- Survey conducted by Forrest (2003):
  - 50 different criteria listed by 75 SLPs
  - Most commonly cited included:
    - inconsistent productions
    - groping/effortful productions
    - general oral-motor difficulties
    - inability to imitate sounds
    - increasing difficulty with sound production as the utterance length increased
    - poor sequencing of sounds
Evidence supports unique and independent speech and non-speech oral motor controls (Green, Moore, & Reilly, 2002; Moore & Ruark, 1996; Ruark & Moore, 1997; Steeve, Moore, Green, Reilly, & Ruark McMurtrey, 2008; Wilson, et al., 2008)

- Visual and auditory feedbacks play roles in the development of motor speech control (Imada, 2006; Wilson, et al., 2008)
- No evidence supporting auditory or visual feedback in the development of non-speech oral motor controls (Wilson, et al., 2008)
Research Questions

- Is there a relationship between oral-motor skills and speech skills in children with CAS?
- Is there a relationship between fine motor skills and speech skills in children with CAS?
- Is there a relationship between oral-motor skills and fine-motor skills in children with CAS?
Methods

• Procedure
• Subjects
• Statistical Analysis
Procedure

- CCHMC Interdisciplinary Apraxia Clinic: developmental pediatrician, speech-language pathologist, and occupational therapist

- Testing included:
  - A neurological examination and complete family and past medical history
  - Preschool Language Scale- 4th edition (PLS-4)
  - Kaufman Speech Praxis Test for Children (KSPT)
  - Peabody Developmental Motor Scales- 2nd edition (PDMS-2)

- Data collected between July 2003 and Oct. 2007
Tests

- Preschool Language Scale- 4th ed. (PLS-4)
  - Auditory Comprehension, Expressive Communication
  - Standard score (mean 100; SD 15)

- Kaufman Speech Praxis Test for Children (KSPT)
  - Oral Movement, Simple Phonemic/Syllabic Level,
    Complex Phonemic/Syllabic Level
  - Standard score (mean 100; SD 15)

- Peabody Developmental Motor Scales- 2nd ed. (PDMS-2)
  - Object-manipulation, Grasping, Visual-motor Integration
  - Standard scores (mean 10; SD 3)
  - Fine-motor Quotient (mean 100; SD 15)
### Subjects

#### Inclusion Criteria

- An age of 2 to 5 years at the time of evaluation
- A clinical diagnosis of CAS
- A standard receptive language score $\geq 85$
- Completed the KSPT

#### Exclusion Criteria

- Diagnosed or reported neurological or developmental disorder
  - Hypotonia, seizure disorder, abnormal reflexes, fragile X, cerebral palsy, autism spectrum disorder
- A known hearing loss
Clinical Diagnosis of CAS

- Standard score <85 on the KSPT (normal population)
- Demonstrated criteria based upon the KSPT Diagnostic Rating Scale Continuum: (Kaufman, 1995)
  - Oral scanning or groping
  - Difficulty maintaining same motor-speech patterns twice
  - Inability to imitate motor-speech patterns of increased length or complexity
  - Intact isolated consonant production, with breakdown at word level
  - Vowel distortions
  - Limited consonant repertoire
  - Sound errors (distortions/weak targets)
  - Inconsistent attempts on words of increased length or complexity
Analysis

- Pearson correlations were run using IBM SPSS© Statistics 19 software
- Determined the relationships between standard scores
  - KSPT oral movement subtest
  - KSPT simple phonemic/syllabic level subtest
  - KSPT complex phonemic and syllabic level subtest
  - PDMS-2 fine-motor quotient (PQuotient)
Results
Subject Demographics

- 49 subjects included
- 8 female (16%), 40 male (81.6%)
- Average age of 42.7 months (Range 24-70 months)
Is there a relationship between oral-motor skills and speech skills in children with CAS?

- Pearson correlation values not found to be statistically significant (p ≤ .01)

<table>
<thead>
<tr>
<th>KSPT-Oral Motor</th>
<th>Pearson Correlation Sig. (2-tailed)</th>
<th>KSPT-Simple</th>
<th>KSPT-Complex</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>.194</td>
<td>.020</td>
<td>14</td>
</tr>
<tr>
<td>N</td>
<td>.243</td>
<td>.945</td>
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</tr>
</tbody>
</table>

- Pearson correlation values not found to be statistically significant (p ≤ .01)
Is there a relationship between fine motor skills and speech skills in children with CAS?

- Pearson correlation values not found to be statistically significant ($p \leq .01$)

<table>
<thead>
<tr>
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<th>KSPT-Simple</th>
<th>KSPT-Complex</th>
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</thead>
<tbody>
<tr>
<td>PDMS-2 PQQuotient</td>
<td>.317</td>
<td>.328</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>.114</td>
<td>.354</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.26</td>
<td>.10</td>
</tr>
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Is there a relationship between oral-motor skills and fine-motor skills in children with CAS?

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<tr>
<td>Pearson Correlation Sig. (2-tailed) N</td>
<td>.523 .001 34</td>
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- Statistically significant correlation (p=.001)
- Moderate correlation, r=.523
## Standard Scores

<table>
<thead>
<tr>
<th>Test</th>
<th>Average Range</th>
<th>Mean</th>
<th>SD</th>
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<tbody>
<tr>
<td>PDMS-2 PQuotient</td>
<td>85-100</td>
<td>90.47</td>
<td>12.12</td>
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<tr>
<td>KSPT-Oral Motor</td>
<td>85-100</td>
<td>84.29</td>
<td>24.49</td>
</tr>
<tr>
<td>KSPT-Simple</td>
<td>85-100</td>
<td>50.59</td>
<td>39.35</td>
</tr>
<tr>
<td>KSPT-Complex</td>
<td>85-100</td>
<td>55.40</td>
<td>28.19</td>
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## Statistical Analysis

<table>
<thead>
<tr>
<th></th>
<th>Mean*</th>
<th>SD**</th>
<th>PQuotient</th>
<th>KSPOMSS</th>
<th>KSPSPSS</th>
<th>KSPCPSS</th>
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<tr>
<td><strong>PQuotient</strong></td>
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<td>0.422</td>
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<td></td>
<td></td>
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<td>15</td>
</tr>
</tbody>
</table>

- **PQuotient**: PMDS-2 fine-motor quotient; **KSPSPSS**: KSPT simple speech standard score; **KSPOMSS**: KSPT oral-motor standard score; **KSPCPSS**: KSPT complex speech standard score

*Mean standard scores; **Standard deviation of standard scores; ***Correlation significant at the 0.01 level (2-tailed)
Discussion

- Limitations
- Future Research
- Clinical Implications
Discussion

- No significant relationship between non-speech motor skills and speech abilities
- Significant relationship ($p=.001$) between oral-motor and fine-motor skills
  - Non-speech fine motor skills have a relationship, but not with speech skills
  - Speech may be a specialized fine-motor skill
- Mean standard scores indicate that severe speech praxis deficits may exist with average oral and fine motor praxis
Limitations

- Sensitivity of testing measures not investigated as well as other published tests
- Hx of speech interventions and progress unknown
- Diagnostic Criteria
  - Lack of ‘gold standard’ and defined diagnostic criteria within the field limits comparison to other studies
  - Clinical Strength—Defined criteria for clinical diagnosis of CAS agreed upon among clinicians
Future Research

- Larger sample size across all domains
- Greater span of ages
- Consider sensitivity of fine-motor, oral-motor, and speech measures
Clinical Implications… Diagnosis

- Existence of oral and fine motor deficits may indicate global dyspraxia
- Speech is needed to give a confirmed diagnosis of CAS
Clinical Implications... Treatment

- Speech and non-speech praxis skills are independent with task-specific motor controls
  - NSOMEs for treatment is not supported
References


