Voice Characteristics of Autism

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ASD: Motor & Motor Speech Impairments

- Approximately 50% remain non-oral throughout their lives
  - (Paul, 1987; Seal & Bonvillian, 1997)
- Oral and verbal apraxias
  - (Marili, 2004; Prizant, 1996; Seal & Bonvillian, 1997)
- Nearly two thirds of children with autism experience difficulties in executing daily routines
  - (Noterdaeme, Mildenberger, Minow & Amorosa, 2002).

ASD: Speech Differences

- Express stress atypically
  - (Paul, Augustyn, Klin & Volkmar, 2005)
- Utterance duration
- Pause duration
  - (Zajac et al., 2006)

Childhood Apraxia of Speech: “Speech motor programming/planning difficulties”

Prosodic Disturbances

- Slower rate of speech
  - Temporal variability
    - Variable durations across both syllables and words
      - (Shriberg, Campbell, Karlsson, Brown, McSweeny & Nadler, 2003; Shriberg, Green, Campbell, McSweeny & Scheer, 2003)
    - Pause events
      - “Coefficient of Variation Ratio”
      - (Shriberg, Green, Campbell, McSweeny & Scheer, 2003)

CAS: Perception of Stress

- Difficulties in acquiring stress patterns
  - (Odell & Shriberg, 2001; Shriberg, Campbell, Karlsson, Brown, McSweeny & Nadler, 2003)
- Articulate correct stress patterns less often than typically developing children or those with phonological delays
  - (Munson, 2003; Skinder, Strand & Mignerey, 1999)

CAS: Stress & Motor Speech Programming/Planning

- Excessive/equal/misplaced stress
  - (Shriberg, Aram, Kwiatkowski & Mignerey, 1999)
- Overall unintelligibility
  - (Skinder, Strand, & Mignerey, 1999)
**Our Previous Findings**

- Significantly decreased maximum phonation time for the vowel [a] to approximately 3 seconds
- Increased formant values, in particular for the vowel [i]
- Decreased pitch, especially in regards to the vowel [i]

*(Boucher, Andrianopoulos, Velleman, Perkins, et al., 2006 & 2007)*

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**Our Previous Findings**

- Slower rate of speech characterized by uniform lengthening across phrases, including both pause length and vowel length in comparison to TD children.
- Difficulty in producing two or more repetitions of syllables in AMR & SMR tasks.

*(Boucher, Andrianopoulos, Velleman, Perkins, et al., 2006 & 2007)*

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**Research Aims**

- To identify voice characteristics of speech among children with ASD
- To compare findings by Perkins, Andrianopoulos, Velleman, and Van Emmerik (2006) of voice differences between children with CAS and TD children.
- To contribute to differential diagnosis and planning of effective speech therapies for ASD and CAS.

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**Methodology: Participants**

**Inclusion/Exclusion criteria**

- Age: 4-6;11
- Diagnosis of ASD
- No cranio-facial or other structural differences
- Vocabulary of at least 50 words, 10 of which must be oral
- No uncorrected hearing or visual deficits
- No history within the past 6 months of self-injury or injury to others or property damage

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**Methodology: Procedure**

- Cross-sectional prospective study ($\alpha \leq 0.05$)
- SPHHS Human Subjects Review
- Evaluation / permission & consent forms
- IQ testing (between 70-90)
- Pure tone hearing screening
- ADOS test administered
Methodology: Variables/ Speech tasks

- Production of:
  - [ɑ]
  - [u]
  - [i]

- Short phrases
  - "pea tea key"
  - "beet boot boat bat"

- Sentences
  - "Buy Bobby a puppy"
  - "Mommy bakes pot pies"

Methodology: Instrumentation & Acoustic Analysis

- Responses recorded onto DAT tapes through a head-mounted microphone (sound-treated booth)

- Multi-Dimensional Voice Profile program (Kay Pentax)

Methodology: Statistical Analysis

- Excel® spreadsheet
  - Average
  - Standard deviations
  - F-tests

- SPSS 17 statistical software package
  - One-way ANOVAs

Results: Fundamental Frequency Measurements

- [ɑ]
  - ASD higher pitch than CAS or TD
  - Also more variable
  - Not a statistically significant difference (p<.262)

- [u]
  - ASD higher pitch
  - Most variable
  - Not a statistically significant difference (p<.813)

- [i]
  - ASD higher pitch
  - Most variable
  - Not a statistically significant difference (p<.770)

Results: Fundamental Frequency Measurements

- "pea tea key"
  - ASD higher pitch than CAS or TD
  - Also more variable
  - Statistically significant difference (p<.036)

- "beet boot boat bat"
  - ASD higher pitch than CAS or TD
  - Also more variable
  - Not a statistically significant difference (p<.725)

- "Buy Bobby a puppy"
  - ASD higher pitch than CAS or TD
  - Also more variable
  - Not a statistically significant difference (p<.558)

- "Mommy bakes pot pies"
  - ASD higher pitch than CAS or TD
  - Also least variable
  - Not a statistically significant difference (p<.782)
**Results: Frequency Perturbation Measurements**

- [a]
  - ASD lowest jitter in %
  - Least variable
  - Not a statistically significant difference (p<.253)
- [u]
  - ASD highest jitter in %
  - Most variable
  - Not a statistically significant difference (p<.897)
- [i]
  - ASD lowest jitter in %
  - Most variable
  - Not a statistically significant difference (p<.335)

**Results: Frequency Perturbation Measurements**

- “pea tea key”
  - ASD lowest jitter in %
  - Less variable than CAS, but more variable than TD
  - Not a statistically significant difference (p<.001)
- “beet boot boat bat”
  - ASD lowest jitter in %
  - Most variable
  - Not a statistically significant difference (p<.141)

**Results: Frequency Perturbation Measurements**

- “Buy Bobby a puppy”
  - ASD lowest jitter in %
  - Less variable than CAS, but more variable than TD
  - Statistically significant difference (p<.026)
- “Mommy bakes pot pies”
  - ASD lowest jitter in %
  - Highly statistically significant difference (p<.000)

**Results: Amplitude Perturbation Measurements**

- [a]
  - ASD highest Shimmer in dB
  - Least variable
  - Not a statistically significant difference (p<.947)
- [u]
  - CAS > ASD > TD
  - CAS least variable, TD most
  - Not a statistically significant difference (p<.494)
- [i]
  - ASD lowest Shimmer in dB
  - Most variable
  - Not a statistically significant difference (p<.370)

**Results: Amplitude Perturbation Measurements**

- “pea tea key”
  - ASD lowest Shimmer in dB
  - More variable than CAS or TD
  - Statistically significant difference (p<.042)
- “beet boot boat bat”
  - ASD lowest Shimmer in dB
  - More variable than TD but less than CAS
  - Not a statistically significant difference (p<.264)
Results: Amplitude Perturbation Measurements

- "Buy Bobby a puppy"
  - ASD lowest Shimmer in dB
  - More variable than TD but less than CAS
  - Not a statistically significant difference (p<.078)

- "Mommy bakes pot pies"
  - ASD lowest Shimmer in dB
  - Least variable
  - Statistically significant difference (p<.012)

Results: Time Related Measurements

- "pea tea key"
  - CAS > ASD > TD
  - CAS most variable
  - Statistically significant difference (p<.02)

- "beet boot boat bat"
  - CAS > ASD > TD
  - ASD most variable
  - Statistically significant difference (p<.046)

Results: Time Related Measurements

- "Buy Bobby a puppy"
  - CAS > ASD > TD
  - ASD most variable
  - Not a statistically significant difference (p<.136)

- "Mommy bakes pot pies"
  - CAS > ASD > TD
  - ASD most variable
  - Not a statistically significant difference (p<.267)

Time Measurements: “Pea tea key”

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<th>Group</th>
<th>Mean</th>
<th>Individual Variability</th>
<th>Group Variability</th>
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</table>

Spectrogram: TD Speaker

Mommy bakes pot pies.
Mommy bakes pot pies.

Mommy bakes pot pies.

Mommy bakes pot pies.

Mommy bakes pot pies.

### ASD group presented with:
- Increased pitch across all tasks
- Lowest jitter %
- Lowest shimmer in dB
- Increased time durations

### Implications
These empirical findings support that intervention for children with Autism should not focus only on pragmatics, MLU, and vocabulary, as is often the case.

Rather, voice and motor speech treatment methodologies should be incorporated as appropriate to individuals with autism.

### Conclusion

- Increased pitch across all tasks
- Lowest jitter %
- Lowest shimmer in dB
- Increased time durations

### References
References continued