Effects of the Picture Exchange Communication System: A Systematic Review

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Background

- Approximately 25% of children on the autism spectrum disorder (ASD) present with little or no functional speech (Volkmar, Lord, Bailey, Schultz, & Klin, 2004; Lord & Bailey, 2002).
- This makes many of these children excellent candidates for the use of augmentative and alternative communication (AAC) approaches (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997).
Background

- Picture Exchange Communication System (PECS)
  - Structured behavioral intervention program to teach use of visual-graphic symbols for communication (Bondy & Frost, 1994)
  - Teaches to make requests by handing/exchanging symbols for desired items
Background

- Picture Exchange Communication System
Background

- Picture Exchange Communication System (PECS) (Frost & Bondy, 1994)
  - Phase I: Physical Exchange
  - Phase II: Expanding Spontaneity
  - Phase III: Picture Discrimination
  - Phase IV: Sentence Structure
  - Phase V: Responding to “What do you want?”
  - Phase VI: Responsive and Spontaneous Commenting
Recent Reviews on the Effectiveness of PECS


Purpose

- To determine the effectiveness of PECS instruction on prelinguistic behaviors, speech production, and expressive social regulation and communicative functions in children with ASD.

- Systematic review methodology is uniquely suited to minimize bias in locating, selecting, coding, and synthesizing this evidence (Petticrew & Roberts, 2006).

- Guided by criteria for appraising systematic reviews (Schlosser, Wendt, & Sigafoos, 2007)
Methods

Criteria for Inclusion

- RCTs, non-randomized group designs, and single-subject experimental designs
- Children between 12 months and 21 years
- Documented diagnosis of ASD
  - Autism Prototype Disorder, Childhood Disintegrative Disorder, Rett Syndrome, PDD-NOS
- PECS as the intervention
  - At least one and as many as six phases
  - Child needs to be the primary target of intervention
- Outcomes include
  - pre-linguistic behaviors (e.g., joint attention), speech production, social regulation functions (e.g., initiating), and communicative functions (e.g., requesting).
Methods

Criteria for Inclusion Continued

- If group-level data and/or analyses, all participants had to be classified as ASD
- Group designs need to involve a treatment group and a 2nd/3rd/4th treatment group or control group
  - to apply standardized mean difference effect size metrics.
- For single-subject experimental designs,
  - at least one outcome needs to lend itself for the calculation of the percentage of non-overlapping data (i.e., graphic display of session-by-session time series testing data; no ceiling effects in the baseline)
- Study is dated between 1994 and 2007.
Methods

Study Selection

- Title and Abstract
- Full text
- Independent coder
Methods

Data Sources

- General-purpose electronic databases
  - CINAHL
  - ERIC
  - LLBA
  - MEDLINE
  - PSYCINFO
  - PROQUEST DIGITAL DISSERTATIONS

- Web Search Tools
  - Google Scholar
  - Scirus
  - Scopus
  - C-2 PROT, C-2 RIPE, C-2 SPECTR
Methods

Data Sources

- Web Search Tools Continued
  - Cochrane Central Register of Controlled Trials
  - Cochrane Register of Systematic Review
  - Database of Abstracts of Reviews of Effects (DARE)
  - National Research Register
  - CRD Register of Reviews
  - Publisher-specific maintained websites
    - [http://www.sciencedirect.com](http://www.sciencedirect.com)
    - [http://www.springerlink.com](http://www.springerlink.com)
    - [http://www.metapress.com](http://www.metapress.com)
  - ASHA, ABA (Autism & International), and ISAAC Conference Proceedings
Methods

Search Strategies
- Free-text searching
  - Picture Communication Exchange Communication System
  - PECS
- Traditional Pearl Growing
- Branching
- Forward citation search
- Manual searches of key journals
- Author searches
  - ISI Web of Science, Scopus
- Personal contacts
- Comprehensive Pearl Growing

Schlosser, Wendt, Angermeier, & Shetty (2005)
Schlosser, Wendt, Bhavnani, & Nail-Chiwetalu (2006)
Methods

Data Extraction

- Research design characteristics
  - Group designs
  - Single-subject experimental designs
- Participant characteristics
  - # of subjects (if group)
  - Disability
  - ASD diagnostic tests
  - Age at ASD diagnosis
  - Severity of autism
  - Degree of intellectual disability (if applicable)
  - Chronological age
  - Gender, Race/Ethnicity
  - Receptive language (standardized test)
  - Expressive language (standardized test)
  - Overall developmental functioning (standardized tests)
  - Speech before intervention
  - Speech imitation before intervention
  - AAC imitation before intervention
  - Pre-intervention modes of expressive communication
Methods

Data Extraction

- Participant characteristics continued
  - Pre-intervention functions of expressive communication
  - Pre-intervention receptive communication
  - History with PECS instruction
  - History with requesting instruction

- Intervention characteristics
  - Adherence to PECS protocol
  - Innovation of the PECS protocol
  - PECS phases implemented
  - Length of follow-up
  - Length of the intervention
  - Density of the intervention schedule
  - Interventionist preparation
Methods

Data Extraction

- Intervention characteristics continued
  - Treatment integrity
  - Type of treatment integrity
  - Treatment integrity % of sessions
  - Treatment integrity observer status

- Outcome characteristics
  - Acquisition or intervention effectiveness outcomes
  - Maintenance effectiveness outcomes
  - Generalization effectiveness outcomes
Methods

Data Extraction Continued

- Outcome measures
- Different quantitative measures for group designs and single-subject designs
- Effectiveness measures for group data
- Cohen’s $d$ and Hedges $g$ (range -3.00 to 3.00)
  - $< .20$: small effect
  - $.20 - .50$: medium effect
  - $.50 - .80$: important effect
  - $>.80$: large effect/ major difference (Cohen, 1977, 1988)
Methods

Effectiveness measures for group data (cont.)
- Pearson’s $r$ (range -1.00 to 1.00)
  - $\leq .1$ : small effect
  - $.3$ : medium effect
  - $\geq .5$ : large effect (Cohen, 1988, 1992)
- $(\Delta)R^2$ (range 0-1): amount of variance accounted for by the treatment effect
Methods

- Effectiveness measures for single-subject data
  - Percentage of Nonoverlapping Data (PND) (Scruggs, Mastropieri, & Casto, 1987)
  - Calculation of non-overlap between baseline and successive intervention phases
    - Identify highest data point in baseline and determine the percentage of data points during intervention exceeding this level
  - easy to interpret
  - non-parametric statistic
Percentage of non-overlapping data (PND)

- Calculation of non-overlap between baseline and successive intervention phases
  - Identify highest data point in baseline and determine the percentage of data points during intervention exceeding this level
- Easy to interpret
- Non-parametric statistic
PND calculation: An example

Baseline Intervention

\[ \text{PND} = \frac{6}{10} = 60\% \]
PND calculation (cont.)

\[
PND = \frac{5}{8} + \frac{7}{8} = \frac{12}{16} = 75\%
\]
Interpretation of PND scores

- If a study includes several experiments, PND scores are aggregated by taking the median (rather than mean)
  - Scores usually not distributed normally
  - Median less affected by “outliers”
- PND statistic: as higher the percentage the more effective the treatment
- Specific criteria for interpreting PND scores outlined by Scruggs, Mastropieri, Cook, and Escobar (1986)
Interpretation of PND scores (cont.)

- PND range 0-100%
  - PND < 50% reflects unreliable treatment
  - PND 50% - 70% questionable effectiveness
  - PND 70% - 90% fairly effective
  - PND > 90% highly effective
Methods

Data Extraction

- Assessment of methodological quality
  - Certainty of evidence
    - Conclusive, preponderant, suggestive, inconclusive (Simeonsson, 1994)
  - Single-subject experimental designs evaluating the effectiveness of one intervention
    - 10-point scale based on Horner et al. (2005) and others
  - Single-subject experimental designs comparing two or more interventions
    - 17-point scale based on Horner et al. (2005) and Schlosser, Sigafoos, & Belfiore (2006).
- Group designs
  - 10-point PEDRO scale (10 points maximum for RCTs; 8 points max for non-RCTs)
- Data Extraction Process
Preliminary Results

- Single-Subject Experimental Design Studies
  - 26 participants across 9 studies
- Group Studies
  - 79 participants across 3 studies
<table>
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<th>N</th>
<th>Phases</th>
<th>DV</th>
<th>PND-Mean</th>
<th>PND Range</th>
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<td>Yoder &amp; Stone (2006a); 38 subjects</td>
<td>1 PECS - (I-IV if within 6 months) 2 RPMT</td>
<td>non-imitative spoken acts</td>
<td>$1T2^a$: 3.6 (4.8) $1T3$: 5.5 (3.2)</td>
<td>$2T2$: 0.6 (4.8) $2T3$: 5.4 (3.2)</td>
<td>Coh. $d$: .63 $d$: -1.53 $L (H)$: .61</td>
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<td>different non-imitative words</td>
<td>$1T2$: 2.4 (3.6) $1T3$: 3.1 (2.4)</td>
<td>$1T2$: 0.6 (3.6) $1T3$: 2.9 (2.4)</td>
<td>Coh. $d$: .50 $d$: -1.12 $L (H)$: .49</td>
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<td>1 PECS - (I-IV if within 6 months) 2 RPMT</td>
<td>Generalized turn-taking</td>
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<td>Carr &amp; Felce (2006a); 41 subjects</td>
<td>PECS I-III (A) vs. control (B)</td>
<td>Child-to-adult initiations</td>
<td>T2: 61.4</td>
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<td>Child-to-adult initiations w adult response</td>
<td>T2: 96.7</td>
<td>T2: 76.9</td>
<td>2.8</td>
<td>&lt; .0026</td>
</tr>
<tr>
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<td>Adult-to-child w no opportunity for child to respond</td>
<td>T2: 13.3</td>
<td>T2: 21.1</td>
<td>-1.65</td>
<td>&lt; .0495</td>
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</tbody>
</table>
Results

- Inconclusive single-subject design studies:
  - Son et al. (2006)
  - Travis (2006)
  - Yokoyama et al. (2006)
Benefits of C-2 Protocol

- Campbell Collaboration
  - [www.campbellcollaboration.org](http://www.campbellcollaboration.org)
- Title approval process
- Protocol approval process
- Peer-review with methodology focus
- Systematic reviews as a living document
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