Evidence-based Interventions in Augmentative and Alternative Communication (AAC) for Autism Spectrum Disorders

What Does the Research Say?

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Program

- Intro: Autism Spectrum Disorders (ASD) and Augmentative & Alternative Communication (AAC)
- Evidence-based Practice in AAC
- Reviewing the AAC in ASD Evidence Base
  - Manual Signs and Gestures
  - Graphic Symbol Sets and Systems
  - Picture Exchange Communication System (PECS)
- Break
  - Speech-Generating Devices (SGDs)
- Moving from PECS to SGDs

Autism Spectrum Disorders (ASD)

Triad of symptoms with
1. Impairments in language and communication
   - Deficits in language can range from completely nonverbal to acquiring the ability to speak.
2. Impairments in social interaction
   - Results in lack of motivation to communicate with other people – even when these individuals have acquired some language competence and use.
3. Restricted and repetitive patterns of behavior
   - Pre-occupation with restricted patterns of interest can impede social and communicative development.

Atypical Communication Development

- Ages associated with early gestures in typically developing (TD) children:
  - Reaching: 6-9 months
  - Giving: 8-11 months
  - Showing: 8-13 months
  - Pointing: 9-14 months
  (Bates et al., 1975; Carpenter et al., 1983)
- Gestures are precursor to later speech and language development
  - Early symbolic form of communication

Atypical Communication Development (cont.)

- Children with ASD tend to rely on more primitive gestures
  - Leading
  - Pulling
  - Manipulating partner’s hand

Atypical Communication Development (cont.)

Gestural use characterized by:
- Fewer gestures are combined with vocalizations than in TD children
- Less pointing (protodeclarative gesturing)
- Fewer conventional gestures
- Use of unconventional behavior to communicate (both verbal and non-verbal)
  (Wetherby et al., 2000)
Language Difficulties

When expressive language develops, first word often spoken between 2-3 yrs., but early language marked by
- Delay in development of intentional communication
- Greater propensity to use challenging behavior to communicate
- Limitations in joint attention, range of communicative functions, higher proportion of imperatives
- Repetitive or idiosyncratic language

(Prelock, 2006)

Language Difficulties (cont.)

Repetitive or idiosyncratic language
- Perseveration
- Echolalia
- Incessant questioning
- Pronoun reversal
- Frequent use of imperatives
- Difficulty with function words
- Comprehension difficulties
- Neologism (producing invented words)
- Challenging behavior to serve social functions
- Speech deviation in pitch, rhythm, and inflection

Proportion of Nonverbal Children

- Autism includes a "delay in, or lack of the development of spoken language" (American Psychiatric Association, 2000)
- 14-25% of children diagnosed with an autism spectrum disorder (ASD) present with little or no functional speech (Lord & Bailey, 2002; Lord, Risi, & Pickles, 2004)
  - Autistic disorder only: 50% of children are functionally non-verbal
  - no sufficient natural speech or writing to meet their daily communication needs (Light, Roberts, DiMarco, & Greiner, 1998) → Candidates for intervention in augmentative and alternative communication

AAC Definition

- Augmentative and Alternative Communication (AAC):
  1. The supplementation or replacement of natural speech and/or writing. (Lloyd, Fuller, & Arvidson, 1997, p. 1)
  2. The area of research, clinical and educational practice … to compensate for temporary or permanent impairments, activity limitations, and participation restrictions of persons with severe disorders of speech-language production, and/or comprehension. (ASHA, 2005, p. 1)

AAC and Autism (cont.)

- AAC strategies particularly used in ASDs:
  - Manual signs and gestures
  - Pictographic symbols sets/systems
  - High technology speech generating devices (SGDs) for synthesized and/or digitized speech output
  - Practitioners face difficult task selecting a suitable approach
  - Evidence-based practice (EBP):
    - Using research outcomes as a major basis for clinical and educational decisions (Lloyd, 2001)

Evidence from Recent Systematic Reviews of AAC in Autism

Results from systematic reviews will be highlighted
- General efficacy of AAC in ASD
Evidence from Recent Systematic Reviews (cont.)

- Manual signs and selection-based graphic symbol sets and systems:
- Exchange-based graphic symbol systems (i.e., Picture Exchange Communication System and modifications), for example,

Why Look At Systematic Reviews?

- Goals: synthesis of the existing experimental research literature on graphic symbol-based interventions
  - Effectiveness measures
  - Quantitative evaluation of study outcomes and study characteristics
  - Quality appraisal of study methodology
- 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)
- Systematic reviews provide practitioners with pre-filtered evidence (Guyatt & Rennie, 2002)

Systematic Reviews Are Pre-filtered Evidence

- Pre-filtered evidence is established when someone with expertise in a substantive area has reviewed and presented the methodologically strongest data in the field (Guyatt & Rennie, 2002).

Data Evaluation

- Most studies employed single-subject experimental designs
- 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

PND Calculation: An Example

```
SESSIONS  OUTCOME
0         2
2         4
4         6
6         8
8         10
10        12
12        14
14

Baseline
Intervention

PND Calculation: An Example

PND = 6/10 = 60%
```
Interpretation of PND Scores

- PND statistic: The higher the percentage, the more effective the treatment
- PND range 0-100%
  - PND < 50% reflects unreliable treatment
  - PND 50% - 70% questionable effectiveness
  - PND 70% - 90% fairly effective
  - PND > 90% highly effective

(Scruggs, Mastropieri, Cook, & Escobar, 1986)

Manual Signs

- Manual signs: unaided form of communication; unaided communication does not rely on any aids or devices external to the body and uses only body parts (Lloyd et al., 1997).
- One of the first forms of AAC applied to non-speaking individuals with ASD; introduced in the 1970s and used successfully for more than 30 years
- Can refer to a natural sign language (e.g., American Sign Language) or to production of manual signs as a code for a spoken language
- By the mid-1980s, manual signing was often used in combination with speech, this approach was labeled as “total” or “simultaneous” communication (SC)

Why Choose Manual Signs?

- Easy to imitate (Sundberg, 1990)
  - Individuals with ASD may have difficulty controlling vocal folds but display strengths with imitating actions
- Signs are less transient than words (Fulwiler & Fouts, 1976)
  - Less frustrating to learn than vocal speech
- May overcome negative history associated with speech (Sundberg & Partington, 1998)

Manual Signs: Empirical Evidence

- Expressive signing
  - 5 studies including 22 participants concentrated on teaching manual signs and monitoring sign production as an outcome variable
    - Anderson, 2001
    - Carr, Binkoff, Kologinsky, & Eddy, 1978 (two experiments)
    - Schepis et al., 1982
    - Tincani, 2004
  - Across experiments teaching manual signs yielded an overall PND of $\text{Mdn} = 100\%$ ($\text{Mn} = 95\%$, $\text{SD} = 17.45\%$) ⇒ “highly effective”

AAC in Autism: What Does the Research Say?

MANUAL SIGNS AND GESTURES

MANUAL SIGNS (cont.)
Manual Signs: Empirical Evidence (cont.)

- Expressive signing, various outcome variables
  - Carr, Kologinsky, and Leff-Simon (1987) taught three individuals to sign action-object phrases: PND scores of "highly effective" for all
  - Hundert (1981) conducted manual sign training with one participant under two conditions: single stimulus training (PND = 67 %) versus multiple stimulus training (PND = 78 %)
  - Keough et al. (1987) and Sommer, Whitman, and Keogh (1988) taught one participant manual signs through specific behavioral scripts: Mdn PND = 83.5 % ⇒ “fairly effective”

Manual Signs: Empirical Evidence (cont.)

- Expressive signing, simultaneous communication (SC):
  - Barrera, Lobato-Barrera, and Sulzer-Azaroff (1980) taught one participant expressive language skills using three different instructional methods:
    - Simultaneous sign training (PND = 89 %)
    - Nonverbal sign-alone training (PND = 56 %)
    - Oral training (PND = 67 %)
  - Simultaneous communication superior to sign alone and oral training

Manual Signs: Empirical Evidence (cont.)

- Expressive signing, simultaneous communication:
  - Remington and Clarke (1983) compared simultaneous communication versus sign alone training in two participants: no difference, both participants achieved PND scores of 100 % in either condition
  - Saraydarian (1994), group study: 10 participants exposed to training program that taught object referents in the form of simultaneous communication, sign alone instruction and oral instruction ⇒ sign alone condition superior, effect size $g = 0.36$ indicating moderate effect

Manual Signs: Empirical Evidence Summary

- Summary:
  - Both groups of experiments, expressive speech and receptive speech, yield high outcome scores
  - Evidence suggests it is a viable communication option
- Possible explanations for effectiveness:
  - Better choice than vocalization because it is easier to prompt an action than a vocalization (Sundberg, 1990)
  - Involves more iconic representation than spoken language (Sundberg)
  - Motor imitation is an easier behavior to teach because the teacher can make use of physical prompting and fading procedures (Sundberg & Partington, 1998)

Manual Signs Limitations

- More and more research studies are revealing motor control problems in ASD
  - Clumsiness
  - Poor muscle tone
  - Difficulty with fine and gross motor skills
- Seen in about 80% of children with autism, but not part of diagnostic criteria (Hilton et al., 2012; Isenhower et al., 2012)
- Children with ASD often acquire only limited sign vocabulary and signs tend to be poorly articulated
- Burden on communication partners: social environment may not be fluent in sign language
Manual Signs Limitations (cont.)

Intelligibility:
- Rotholz et al. (1989): two adolescents with autism were taught to order fast food interacting with staff unfamiliar to them
  - 0-25% of manual sign requests were understood
  - 80-100% of graphic symbol requests were understood

Manual Signs Conclusions

- Future research implications:
  - Lack of studies comparing manual signing or gestures against an aided mode of communication such as graphic symbols
  - More comparative efficacy studies are needed to clarify if learners with autism actually do better and/or have a preference for one communication modality over another
  - How to use manual signs as part of a multi-modal communication system consisting also of graphic symbols, communication boards, SGDs, and vocalizations (when available)
  - Need research into effective strategies for teaching the conditional use of manual signs

Gestures

- Gestures: body movements or sequences of coordinated body movements to represent an object, idea, action, or relationship without the linguistic features of manual signs
  - Examples: pointing or yes-no headshakes
  - One of the earliest developing non-linguistic forms of unaided communication (Loncke & Bos, 1997)
  - Individuals with autism, however, rarely use gestures as an alternative communication strategy, even if they have difficulty speaking (Loveland, Landry, Hughes, Hall, & McEvoy, 1988)

Why Choose Gestures?

- Use of gestures serves as a precursor to later development of language skills (Morford & Goldin-Meadow, 1992)
- Gestural behavior also important for establishment and maintenance of social interaction and social reciprocity (Garfin & Lord, 1986; Koegel & Frea, 1993)
- Appropriate for early AAC intervention to facilitate symbolic development
- Motor demands not as much of an issue as with manual signs

Gestures: Empirical Evidence

- Two studies focused on teaching gestural communication skills
  - Buffington, Krantz, McClannahan, and Poulson (1998) taught gestures in combination with oral speech, measured frequency of correctly produced gestural and verbal responses: PND scores of “highly effective” for all four participants
  - Carr and Kemp (1989) provided training in communicative pointing (e.g., to obtain toy), observed frequency pointing occurred: again PND scores of “highly effective” for all four participants

Gestures: Empirical Evidence Summary

- Summary:
  - Appears to be very effective communication option but limited amount of studies at this time
  - Compared to manual signs it seems that gestures are underrepresented and not well researched in this population
    - Surprising, because of its correlation with vocal use and preceding speech development
  - More research needed to build up the empirical support for gestural communication
    - Also need more comparative efficacy studies
AAC in Autism: What Does the Research Say?

**SELECTION-BASED GRAPHIC SYMBOL SETS AND SYSTEMS**

**Graphic Symbol Sets and Systems**
- Graphic symbols: relatively new AAC mode for children with ASD in practice as well as in the development of a research base
- As early as the 1980s authors have drawn attention to the potential benefits of graphic symbols due to their non-transient nature (e.g., Schuler & Baldwin, 1981)
- Graphic symbols are part of sets or systems
  - Sets are collections of symbols that do not have clear rules for their creation
  - Systems are rule-governed (see Lloyd et al., 1997)
- Iconicity hypothesis: symbols having a strong resemblance to their referents are easier to learn (Fuller, Lloyd, & Stratton, 1997)

**Why Choose Graphic Symbols?**
- Good fit with visuo-perceptual strength in ASD
- Can be highly iconic and easy to learn
- Can be combined with verbal model for augmented input
- Easily understood by unfamiliar communication partners
- Often used across various activities and environments (e.g., visual schedules, story book reading, etc., in addition to communication board)
- Easy to produce and cost-efficient low technology strategy

**Intervention Outcomes: Line Drawings**
- Basic Rebus
- Pictogram Ideogram

<table>
<thead>
<tr>
<th>Study</th>
<th>Participant (Age)</th>
<th>Outcome variable</th>
<th>PND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dettmer et al., 2000</td>
<td>Jeff (7-0)</td>
<td>Decrease in latency to begin new activity</td>
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<td></td>
<td>Josh (5-0)</td>
<td></td>
<td>100</td>
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<tr>
<td>Reichle &amp; Brown, 1986</td>
<td>Subject 1 (23-0)</td>
<td>Object labeling</td>
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<tr>
<td></td>
<td></td>
<td>Locating symbols</td>
<td></td>
</tr>
<tr>
<td>Reichle et al., 1991</td>
<td>Ali (27-0)</td>
<td>Correct requests</td>
<td>100</td>
</tr>
<tr>
<td>Sigafos, 1998</td>
<td>Larry (6-6)</td>
<td>Touching symbols for requests</td>
<td>83</td>
</tr>
<tr>
<td>Sigafos et al., 1996</td>
<td>Cleo (17-0)</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Karen (12-0)</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

**Intervention Outcomes: Orthographic Symbols**
- Hebrew Orthography
**Intervention Outcomes: Orthographic Symbols (cont.)**

- Orthographic symbols:
  - Hetzroni and Shalem (2005) combined orthographic symbols from Hebrew alphabet with food item logos in computer-based intervention to teach the meaning of orthographic symbols; mixed results of effectiveness:

<table>
<thead>
<tr>
<th>Participant (Age)</th>
<th>Speech/Language</th>
<th>Outcome variable</th>
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<tbody>
<tr>
<td>Max (11)</td>
<td>1-word utterances</td>
<td>Number of correct responses</td>
<td>67</td>
</tr>
<tr>
<td>Bob (11)</td>
<td>no speech</td>
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<td>70</td>
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<tr>
<td>Gina (13)</td>
<td>not verbal</td>
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<td>88</td>
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<tr>
<td>Lara (10)</td>
<td>no vocalizations</td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Sara (10)</td>
<td>echolalia</td>
<td></td>
<td>82</td>
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<tr>
<td>Al (10)</td>
<td>echolalia</td>
<td></td>
<td>50</td>
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</tbody>
</table>

**Intervention Outcomes: Picture Communication Symbols (PCS)**

- Picture Communication Symbols (PCS)
  - Study
    - Hamilton & Snell, 1993
      - Carl (15): Correct responses using communication book
    - Spillane, 1999
    - Johnston et al., 2003
      - Brad (4-3): Correct use of symbolic communication (graphic symbol or verbal response)
      - Alex (5-3)
      - Billy (5-1)

<table>
<thead>
<tr>
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<th>Outcome variable</th>
<th>PND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamilton &amp; Snell, 1993</td>
<td>Carl (15)</td>
<td>Correct responses using communication book</td>
<td>95</td>
</tr>
<tr>
<td>Spillane, 1999</td>
<td>John (1)</td>
<td>Correct responses: discrete trial Corr. responses Incidental teach.</td>
<td>18</td>
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<tr>
<td>Johnston et al., 2003</td>
<td>Brad (4-3)</td>
<td>Correct use of symbolic communication (graphic symbol or verbal response)</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Alex (5-3)</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Billy (5-1)</td>
<td></td>
<td>45</td>
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</table>

**Intervention Outcomes: PCS in Aided Language Stimulation**

- PCS as part of Aided Language Stimulation (AiLS):
  - Instructional approach: Communication partner provides a verbal model supported by AAC use (Goossens', Crain, & Elder, 1992)
  - Graphic symbols can be one option for delivering this additional input
  - Spoken language input in return may contribute to learning the meaning associated with a graphic symbol

<table>
<thead>
<tr>
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<th>Speech/Language</th>
<th>Outcome variable</th>
<th>PND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andre (8-1)</td>
<td>Limited verbal output</td>
<td>Number of PCS pointed to</td>
<td>74</td>
</tr>
<tr>
<td>Tony (9-2)</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Peter (9-3)</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Carl (9)</td>
<td></td>
<td></td>
<td>84</td>
</tr>
<tr>
<td>Sam (7-2)</td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Brad (6-5)</td>
<td></td>
<td></td>
<td>90</td>
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**Intervention Outcomes: Photographs**

- Photographs
**Intervention Outcomes: Photographs (cont.)**

- Photographs:

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<th>Study</th>
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<td>Spencer, 2002</td>
<td>Tom (7)</td>
<td>Number of requests</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Nathan (7)</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Donald (7)</td>
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<td>100</td>
</tr>
<tr>
<td></td>
<td>Chase (9)</td>
<td></td>
<td>100</td>
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<tr>
<td>Stiebel, 1999</td>
<td>Steven (4-2)</td>
<td>Spontaneous picture card use to communicate</td>
<td>100</td>
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<tr>
<td></td>
<td>Tommy (6-8)</td>
<td></td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Jose (4-6)</td>
<td></td>
<td>71</td>
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**Intervention Outcomes: Various Graphic Symbols (cont.)**

- Various graphic symbol-based interventions:
  - Kozleski (1991) compared acquisition rates of Blissymbolics, colored photographs, orthography, Premack symbols, and rebus across four individuals: fewer sessions were needed for highly iconic symbols; PND “highly effective” in each case
  - Reichle et al. (2005) taught use of a colored graphic symbol (unspecified, PCS?) to a 40 yr old subject: PND score of “questionable effectiveness”
  - Sigafoos et al. (1996) trained two girls (7 and 15 yrs) with Rett syndrome to request food items using a “WANT” symbol with a food item logo: “highly effective” for one, too difficult for other girl

**Intervention Outcomes: Final Results**

- Summary: Most solid empirical evidence: use of graphic symbols for the teaching of requesting skills
  - In addition to requesting, the evidence in support of using graphic symbols as part of visual schedules is suggestive (but 1 study only)
  - Children with ASD seem to be able to match graphic symbols to orthographic symbols, but it is yet to be examined whether this matching could lead to enhanced communication
EXCHANGE-BASED GRAPHIC SYMBOL SETS

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

Why Choose PECS?

- Requires very few prerequisites
  - Only prerequisite individual can clearly indicate wants and needs
- First skill taught in PECS is requesting
  - Often targeted in early instruction of individuals with developmental disabilities due to motivational considerations (Reichle & Sigafoos, 1991)
- Systematically targets spontaneous communication acts, a particular deficit in autism
- PECS graphic symbols are highly iconic
  - Can be easily recognized by the learner and are more recognizable by communicative partners

<table>
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<tr>
<th>Study</th>
<th>N</th>
<th>Phases</th>
<th>DV</th>
<th>PND-Mean</th>
<th>PND-Range</th>
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<td>1</td>
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<td></td>
<td></td>
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<td>47 (I)</td>
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<td>31 (Q)</td>
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<td>I (II as best treat. )</td>
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<td>Words/appr. Signing</td>
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<td>100 (H)</td>
<td>100</td>
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<td>0</td>
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<td>Word approximation</td>
<td>6 (I)</td>
<td>0-11</td>
<td></td>
</tr>
<tr>
<td>Charlop-Christy (2002)</td>
<td>3</td>
<td>I-IV</td>
<td>Eye contact, joint attention or play</td>
<td>100 (H)</td>
<td>100</td>
<td>Suggestive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Requests and initiations</td>
<td>87 (F)</td>
<td>60-100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elicited vocalizations</td>
<td>44 (I)</td>
<td>25-90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Speech imitation</td>
<td>34 (I)</td>
<td>25-50</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MLU</td>
<td>31 (I)</td>
<td>17-50</td>
<td></td>
</tr>
</tbody>
</table>
Considerable empirical support for using PECS as a beginning communication strategy. Methodological issues in PECS studies:

- Often lack investigation of maintenance
- Skill generalization sometimes reported, but what counts as generalization varies greatly
- Participant descriptions lack detail
- Sparse reports of treatment integrity

PECS appears as a promising intervention that presents with emerging empirical support, but critical questions are still to be answered.

PECS Summary:

- Conclusive evidence for decision-making
- PECS more effective than RPMT in terms of speech production
- RPMT better choice in terms of generalization, turn-taking, and initiating joint attention
- Depending on treatment goal the treatment choices may differ
- Important whether or not a child comes to the task with pre-existing object exploration skills and/or joint attention skills

PECS Summary (cont.):

- Another potential choice: use of Responsive Education and Prelinguistic Milieu Teaching (RPMT) relative to PECS
- Studies by Yoder and Stone (2006 a,b) offer conclusive evidence for decision-making
- RPMT more effective than PECS in terms of speech production
- RPMT better choice in terms of generalization, turn-taking, and initiating joint attention
- Depending on treatment goal the treatment choices may differ
- Important whether or not a child comes to the task with pre-existing object exploration skills and/or joint attention skills.
**PECS Future Directions**

- Identifying predictors of successful PECS use by itself and relative to other treatment choices
- Research into innovations of the PECS protocol using rigorous methodologies
- Role of PECS for managing problem behavior still in its infancy
- Future research needs to adhere to more rigorous designs
  - Randomization of participants
  - Treatment integrity assessments
  - Reliability of measures
  - Avoid vague measures that collapse multiple behaviors

**Speech-Generating Devices (SGDs)**

- Portable, computerized devices producing synthetic or digitized speech output when activated
- Graphic symbols are used to represent messages, activated by finger, switch, head stick, etc., selecting a symbol from the display
- LightWRITER
- BIGMack

**SGDs (cont.)**

- **Fixed Display**
  - Graphic symbols located in separate squares of a grid, organized into rows and columns
  - Limited vocabulary

- **Dynamic Display**
  - Selection from a display results in a new array of graphic symbols
  - Larger vocabulary sets

**SGDs (cont.)**

- **Visual Scene Displays**
  - Language concepts are embedded into contextual scenes
  - Objects and events within the photograph are then used as symbols for communication
  - May be used in a dynamic display system
SGDs (cont.)

- Example of a child with ASD using an SGD:
  - [http://www.youtube.com/watch?v=s4GAX-IXE_k&NR=1](http://www.youtube.com/watch?v=s4GAX-IXE_k&NR=1)
- Example of synthetic speech output:
  - [http://www2.research.att.com/~ttsweb/tts/demo.php#top](http://www2.research.att.com/~ttsweb/tts/demo.php#top)

Why Choose SGDs?

- Allows composing more detailed messages
- Enable user to communicate very precise requests and prevent communication breakdown
- Voice output (aka speech output) may facilitate acquisition and maintenance of communication skills
- Producing speech can be perceived as more natural
- Better intelligibility
- Easier to get attention
- Higher likelihood of receiving a listener response

Why Choose SGDs? (cont.)

- iPads and other tablet devices are
  - Lightweight and portable
  - Cost-efficient compared to dedicated SGDs
  - Easy to program
  - Highly motivating to use
  - Socially appealing (peer acceptance)

SGDs: Empirical Evidence

- Van der Meer, & Rispoli (2010), systematic review:
  - Found 23 studies with a total of 51 children aged 3-16 years
  - Positive outcomes reported for 86% of studies, most commonly targeting requesting skills
  - Potentially effective option for teaching communication skills in ASD
- Ganz et al. (2012), meta-analysis:
  - Included 8 studies on SGDs, 9 studies on PECS, 7 other graphic symbols
  - Effect size estimates were 99% each for SGDs and PECS, 61% for others
  - SGD or PECS use yields significantly higher effects

SGDs: Empirical Evidence (cont.)

- Schlosser et al. (2009): “…SGDs represent a viable and effective AAC option for individuals with ASD”
- Empirical evidence speaks a clear message, effectiveness of SGDs no longer a question
  - Important when applying for SGD funding from insurance agencies
Hypothesis: synthetic speech more motivating for children with autism because of essential differences to natural speech (Schlosser & Blischak, 2001)
- No prosodic variation \( \Rightarrow \) more "robotic speech"
- No intonation changes that indicate the emotional state of the speaker (e.g., anger, fear, etc.)
\( \Rightarrow \) This lack of variability in synthetic speech may (a) help with auditory processing, and (b) fit with the speech patterns of echolalia, repetitive speech, and insistence on sameness observed in individuals with autism

Effects of Speech Feedback

Effects of Speech Feedback (cont.)

- Outcome data for speech-on and speech-off conditions were extrapolated
- Four different outcome variables in this sample:
  1. Frequency of spontaneous utterances
  2. Words spelled correctly
  3. Requesting
  4. Number of vocalizations
- For each outcome variable and for total sample, a series of pair-wise Mann-Whitney U tests were conducted to evaluate significant differences between speech-on and speech-off

Effects of Speech Feedback: Results

- Overall effect of speech on vs. speech out
  - Speech on: Mdn PND = 63.0% (Mn = 50.83%, SD = 38.07)
  - Speech off: Mdn PND = 3.0% (Mn = 30.80%, SD = 38.97)
\( \Rightarrow \) No statistically significant difference, \( z = -1.901, p = .057 \)
- Not a reasonable comparison, because of different outcome measures
- More detailed analysis by outcome variable reveals:
Effects of Speech Feedback: Results (cont.)

- Frequency of spontaneous utterances
  - Speech on: Mdn PND = 87.5% (Mn = 83.3%, SD = 19.03)
  - Speech off: Mdn PND = 0% (Mn = 1.5%, SD = 3.67)
  ⇒ Statistically significant difference, \( z = -2.99, p < .01 \)
- Words spelled correctly
  - Speech on: Mdn PND = 91% (Mn = 88.8%, SD = 8.96)
  - Speech off: Mdn PND = 91% (Mn = 86.2%, SD = 14.17)
  ⇒ No difference between conditions, \( z = 0.00, p = 1.00 \)

Requests

- Speech on: Mdn PND = 33.0% (Mn = 41.2%, SD = 14.46)
- Speech off: Mdn PND = 30.0% (Mn = 38.2%, SD = 38.06)
⇒ No statistically significant difference, \( z = .256, p = .805 \)

Number of vocalizations (elicited plus regular)

- Speech on: Mdn PND = 0% (Mn = 2.71%, SD = 7.18)
- Speech off: Mdn PND = 0% (Mn = 0.71%, SD = 1.89)
⇒ No difference between conditions, \( z = 1.05, p = 1.00 \)

For all comparisons, need to consider very small sample of studies and small number of data points
Definitely need more data to clarify role of speech output
Should focus on one specific outcome variable instead of several

SGDs Summary

- Ample evidence of positive effects of SGDs, but effectiveness may vary depending on targeted outcome variables
  - Most clearly effects for teaching requesting
  - Variation in participants’ performances and responses to SGDs
- Benefits of speech feedback not clear at this point
  - Need for further replication studies
- Strong need for further data-based information on effects of SGDs, especially tablet devices

SGDs Summary (cont.)

- Methodological Issues:
  - No (quasi-)experimental group studies
  - Need to incorporate maintenance and generalization assessments
    - Many studies limited to school setting
    - Few studies report treatment integrity
    - Narrow focus on requesting skills
  - Need to target more advanced communication using SGDs

Future Research

- Need for more predictor studies, identifying participant characteristics that serve as predictors of treatment outcomes
- Role of SGDs in facilitating speech production is still in its infancy and needs further investigation
- Need for more comparative efficacy studies comparing aided vs. unaided AAC strategies
- Studies with methodological weaknesses need replication
MOVING FROM PECS TO SPEECH-GENERATING DEVICES

Wendt: Evidence AAC in Autism
CARD Conference 2011

AAC in Autism: What Does the Research Say?

SGD Advantages
- Additional provision of speech output presented as (a) antecedent auditory stimuli (a.k.a. “augmented input”), and/or (b) consequence auditory stimuli (a.k.a. “feedback”) may benefit learners with developmental disabilities
- Gains in receptive and expressive language skills in adolescents with intellectual disabilities using SGDs (Romski & Sevcik, 1993, 1996)
- SGD may allow more independent form of communication (voice output understood by variety of familiar and unfamiliar comm. partners)

Research Questions
- Practitioners/parents: after successful mastery of (initial) PECS phases, can the child move on to a SGD? (Grether, 2007)
- “…research into innovations to the PECS protocol is a laudable direction and should be continued using rigorous methodologies” (Schlosser & Wendt, 2008)
- Project goals:
  - Modify traditional PECS protocol for implementation and transition to an SGD
  - Evaluate the effects of such a modified PECS protocol on increasing requesting skills, social-communicative behaviors, and emerging speech
  - Evaluate effectiveness of a particular device for such purpose that is built upon PECS principles

Experimental Design
- Multiple Baseline Design across participants (Baer, Wolf, & Risley, 1968)
- Intervention phase split into PECS phases and SGD phases, followed by maintenance phase
- 3 children, 9-11 yrs., severe autism and non-verbal
- Dependent measures:
  - Requesting skills: number of correct requests during 20-trials session
  - Social-communicative behavior: number of responses including eye contact, physical orientation towards comm. partner, positive affect via smiling/laughter
  - Emerging speech: word vocalizations or word approx.

Materials and Setting
- Traditional PECS book with PCS symbols for desired items
- Proxtalker - “sentence strip that actually speaks”: picture card is put on ProxTalker display ⇒ speak out the symbol referent in form of prerecorded digitized speech
  - Several picture cards can be combined to speak sentences
  - Symbols used were identical to PECS symbols
- Departmental Speech Clinic, 3 sessions per week

SGD Advantages

Experimental Design

Materials and Setting

Research Questions
**Modified PECS Protocol**

(Preference Assessment)
- 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

(Original PECS protocol by Bondy & Frost, 1994)

**Baseline Video Clip**

**PECS Phase I Video Clip**
End

**ProxTalker Phase II Video Clip**
Beginning

**ProxTalker Phase V**
End
Ipad Phase End

- Moving from Mid-Technology (ProxTalker) to High-Technology (iPad)

Effects on Requesting Skills

Effects on Social-Communicative Behavior

Effects on Emerging Speech

SpeakAll!

- The purpose is to help teach the process of constructing sentences
- Customizable to each child’s specific needs
  - Allows the instructor to use recorded audio and custom images
- Seamlessly connects with PECS or ProxTalker intervention
- Selection Area on top replaces PECS book
- Sentence Strip at bottom speaks selected graphic symbols
- "Shuffle button" randomly regroups graphic symbols
- **DOWNLOADABLE ON ITUNES** (free app)
  - Appstore>Education>Purdue>SPEAKall!
Current iPad-SpeakAll Research

- Multiple Baseline Design across settings (Baer, Wolf, & Risley, 1968)
  - Intervention repeated across clinic, home, and school environments following PECS instructional phases
  - iPad with SpeakAll replaces ProxTalker, intervention starts immediately with iPad
- Dependent measures:
  - Requesting skills: number of correct requests during 20-trials session
  - Emerging speech: word vocalizations or word approx.
**Ipad and SpeakAll!**
- Participant 2 – End

**Ipad and SpeakAll!**
- Participant 3 - Baseline

**Ipad and SpeakAll!**
- Participant 3 – Middle Stages

**Ipad and SpeakAll!**
- Participant 3 – End

**SpeakAll! in the News**
- Journal and Courier
- Indianapolis Star
- Inside INdiana Business
- Case In Point Healthcare Newsletter
- WLFI News Channel 18
- WTHR 13 Eye Witness News Indianapolis
- Part of CNN documentary on apps for autism (producer: Supraja Seshadri)
  - Over 4,250 downloads since Nov. 2011

**WLFI News Channel 18 Report**
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Questions ???

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References: PECS Studies

### References: PECS Studies (cont.)


### References: SGD Studies


### References: PECS to SGDs


### References: SGD Studies (cont.)


### References: PECS to SGDs (cont.)


