Designing evidence-based AAC systems for young children to enhance language & communication development

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For handouts visit http://aac.psu.edu

RERC on AAC

Development of communication, language & literacy skills

- During the first 5 years of life, typically developing children demonstrate remarkable growth
  - from birth when they are
    - preintentional & presymbolic
  - to the start of school years when they are able to
    - express a wide range of intents
    - understand & express thousands of vocabulary concepts
    - generate complex sentences to communicate ideas
    - tell stories, provide explanations, & develop persuasive arguments
    - acquire conventional literacy skills to read & write

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Benefits of AAC intervention

- Growing body of research that demonstrates that AAC intervention can have a positive effect on communication of individuals with CCN
  - Turn taking /participation
  - Requesting/ commenting
  - Receptive & expressive vocabulary
  - Length & complexity of messages
  - Phonological awareness /reading & writing skills
  - Challenging behavior, etc.
- These benefits are realized at no risk to speech development

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Language and communication outcomes for children with CCN

- Despite this potential, most children with CCN
  - Experience significant limitations in their communicative competence
  - Demonstrate limitations in pragmatic, semantic, syntactic, & morphological knowledge & skills
  - Enter adulthood without functional literacy skills
- But it does NOT have to be this way

How can we improve AAC intervention to maximize outcomes for young children with complex communication needs?

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Effective AAC intervention involves 4 components

- Intervention with the child with complex communication needs
  - **Effective developmentally appropriate AAC systems**
  - Instruction in linguistic, operational, social, and strategic skills to develop communicative competence
- Intervention with primary partners
  - Ensure opportunities for communication
  - Ensure appropriate supports for effective communication

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Lack of attention to the design of AAC systems/ technologies

- To date, we have given only limited attention to the design of AAC systems for children
  - Even with the advent of mobile technologies /apps
- Lack of attention to the design of AAC systems/apps for children with CCN is ironic
  - This component of intervention substantially affects performance AND
  - It is the intervention component that is most easily amenable to change

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Goals of the presentation

- To reflect on traditional approaches to AAC systems
- To suggest a new approach to AAC system design driven by children's needs & skills
- To share snapshots of research studies that may inform us about the design of more effective AAC systems for young children
- To consider directions for future research & development to improve the design of AAC systems for young children

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Designing effective AAC interventions for young children

- In order to be optimally effective, AAC interventions should be driven by
  - Child's needs and skills
- But is this what we actually do?
  - Let's consider current AAC systems/ apps

Why do we design AAC systems for children in the way we typically do?

- Typically designed by nondisabled European American adults
  - Reflect perspectives of the developers
- Children with CCN have different perspectives
  - Age/ developmental status
  - Culture/ ethnicity
  - Disability status

The design challenge

- Children with CCN may <u>not</u> find AAC systems
  - Appealing
  - Easy to learn or use
- Research suggests that young children have difficulty with traditional AAC systems
  - Selecting AAC symbols (Drager et al., 2003; Light et al., 2004)
  - Comprehending symbols & expressing simple messages (Trudeau, Sutton & Morford, 2014)

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The challenge

- How do we design AAC systems that are
  - Developmentally appropriate?
  - Dynamic?
  - Easy to learn & use?
  - Appealing to young children?

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Putting children first

- Propose a new approach to designing AAC systems
  - Puts children first
  - Starts with young children's needs and skills to drive the design
  - Results in AAC systems that are
    - Developmentally appropriate
    - Dynamic
    - Easy to learn and use
    - Appealing

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What do we know about child development generally?

- Vision development
  - Near vision develops first
  - Visual attention to people powerful
- Motor development
  - Children develop control from "inside out"
    - Best control at midline
  - Contact gestures develop first; later distal
- Cognitive /linguistic development
  - Initial attention to person or object /event
    - Later coordinated joint attention to person & object/ event
  - Initially children are context-bound
    - Learn new concepts in context
  - Rely on event schema to support communication
    - Develop displaced "talk" later
    - Develop metalinguistic skills much later

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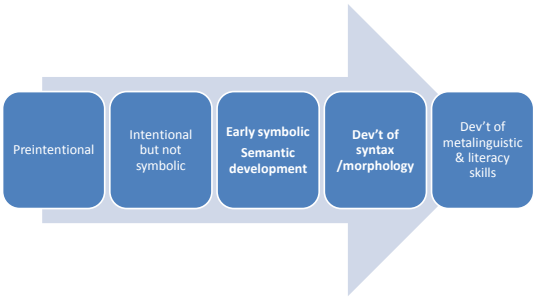
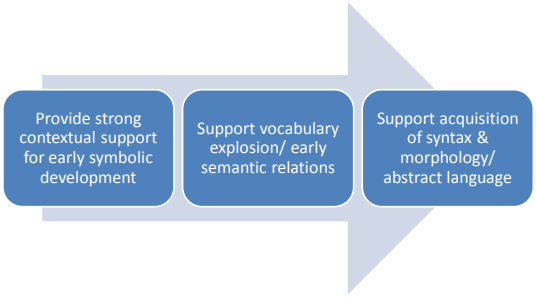
Process of child language development



What do we know about language development?

- Children's language systems
  - Differ significantly from those of adults
  - Change significantly over time as the children develop
- At each stage of language development, children demonstrate
  - Quantitative differences
  - Qualitative differences
- We need to design AAC systems
  - To fit children's needs & skills at each stage
  - To accommodate developmental changes seamlessly

Requirements for AAC systems to support young children



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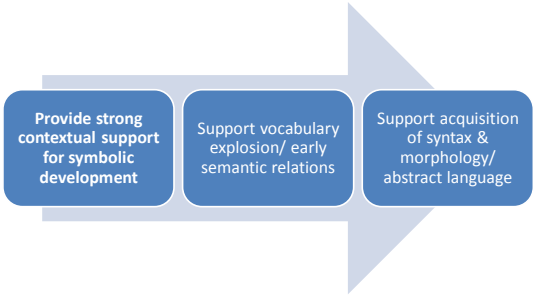
AAC systems for beginning communicators



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Designing AAC systems for beginning communicators

- 5 key components of AAC systems
  - Representation of language concepts
  - Organization and layout of these concepts
  - Navigation
  - Selection
  - Output

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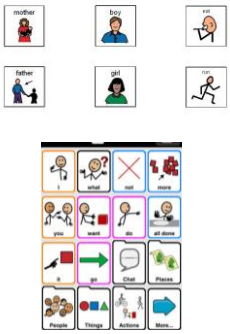
How should we **represent language concepts** for young children with CCN?

How do we map the internal developing language system of children with CCN to the external AAC system/app?

Traditional AAC symbols



- Language concepts represented by separate AAC symbols
- Representations take language concepts out of context
- Understanding symbols relies on semantic memory
  - "dictionary" definition

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How do young children represent language concepts?

- Research questions (Light, Worah, Bowker, Drager, Burki, D'Silva, Kristiansen, Jones, & Hammer, 2012)
  - How do young children from different cultural backgrounds represent early emerging abstract language concepts graphically?
  - How do the children's graphic representations compare to those of existing AAC symbol sets?
  - Do young children understand traditional AAC symbols?

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How do young children represent language concepts?

- Participants
  - 50 typically developing children; ages 3-6 years
  - 5 different cultural groups
    - African American; Hispanic; European American; Immigrants from India; Norwegian
- 10 early emerging language concepts
  - all gone, big, come, eat, more, open, up, want, what, who
- Two tasks
  - Asked to draw concepts & describe their drawings
  - Shown PCS for concepts & asked to name PCS

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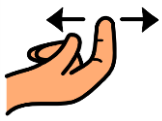
Come

- Only 10% identified the PCS for come
  - Others thought it was "pointer finger", "a boo-boo", "two driveways and a hand", etc



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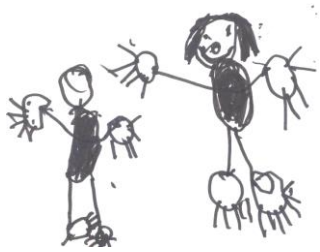
Children's representation of "come"



"Somebody's coming, my friend is visiting."

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Traditional AAC symbol - big

- 0% identified the PCS for big correctly
  - The children thought it was "ants", "sludge", "coloring", "blacktop for basketball", "chocolate", "germs", etc.

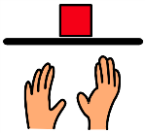
Most of the children drew a person that was big – powerful, capable

"This is me. I'm big and I'm pushing my brother."

(5 year old; African American)

Want

- Only 4% identified the PCS for want
  - The others thought it was "a TV", "cut off hands", "hands and soap", etc



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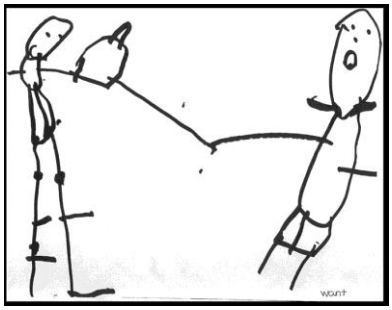
Children's representation of "want"



"That's me. That's my brother. And I want it."

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Who

- 0% identified the PCS for who
  - The children thought it was "a back of a head", "a boy eating", "a hair cut", "a 7 with ears", etc

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Children's representation of "who"

"Girl says, 'Mom, who is that?'
'This is your new daddy.'

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How do children's representations differ from traditional AAC symbols?

- Reflect different underlying conceptualizations
- Include depictions of entire scenes or events
  - Concepts are embedded in context
  - Scenes include familiar people and events
- Seldom include parts of objects or people
  - Parts require inference of the complete object/ person & intent
- Do not include emblems or arbitrary symbols
  - E.g., arrows, movement lines, punctuation

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Implications for representing language concepts

- Young children do **not** initially understand most traditional AAC symbols
- Lack of transparency of AAC symbols
  - Adds additional cognitive demands
    - Learn language concept
    - AND learn representation /symbol
      - There is no inherent value in learning this symbol
- Additional learning demands slow down rate of language learning

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How should we **represent, organize, & layout** displays for young children with CCN?

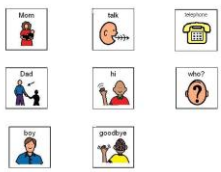
How do we maximize understanding and use of language via AAC?

Traditional AAC displays

Traditional grid layout

- Each language concept is represented by separate AAC symbols in "boxes" organized in rows & columns
- Language is taken out of context; understanding relies on semantic memory
- Each representation must be processed separately, understood, & then integrated

Grid for "playing telephone"



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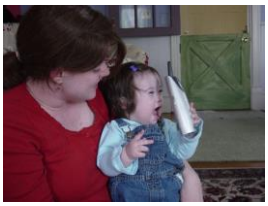
Alternative approach to AAC displays Visual scene displays

Visual scene display (VSD)

- Vocabulary embedded under "hot spots" in integrated visual scene
- Language is presented in meaningful context
- Scene is processed as an integrated unit
- Meaning is derived from the entire scene

VSD for "playing telephone"



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Research on layout of AAC displays

- Series of studies to investigate the effects of different layouts
  - Grid displays
  - Visual scene displays
- Investigate performance of children across various developmental stages
  - Infants (9-12 months old)
  - Toddlers (2 & 3 years old)
  - Preschoolers (4 & 5 year olds)

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Research on the effect of type of display

- Infant study (Wilkinson & Light, in progress)
  - 4 different contexts familiar to infants
    - Feeding, bathing, playing ball, etc
  - Infants viewed pairs of AAC displays for each context
    - E.g., PCS grid vs. photo VSD
    - Position & order counterbalanced
  - Eye tracking technology
    - Measure visual attention / interest

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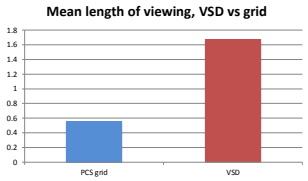
Type of display affects visual attention of infants

- Infants looked first & longest at photo VSD compared to PCS grid
- Infants at "first words" stage demonstrated strong preference for photo VSDs



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Research on the effect of type of display

- Studies with toddlers and preschoolers
  - 2 ½ year olds & 3 year olds
    - Drager, Light, Curran-Speltz, Fallon, & Jeffries, 2003
    - Drager, Light, Carlson, et al., 2004
  - 4 & 5 year olds
    - Light, Drager, McCarthy, et al., 2004
- Methods
  - Children asked to locate vocabulary using different types of displays & to use displays communicatively
    - VSDs (organized by event)
    - Traditional grid organized schematically (by event)
    - Traditional grid organized taxonomically (by category)

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What does research tell us?

- Toddlers were more accurate locating vocabulary using VSDs than grid displays (Drager, Light, et al., 2003)
- It was not until children were 4 & 5 years old that they were able to locate vocabulary with similar accuracy using VSDs or grid displays (Light, et al., 2004)

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What does research tell us?

- 4 & 5 year olds performed much more accurately with VSDs or grids than with iconic encoding/ Minspeak (Light, et al., 2004)
- By the time children are 4 & 5 years old they are acquiring basic literacy skills
  - Require systems with access to traditional orthography (Light & McNaughton, 2009)

Implications for designing AAC displays for children with CCN

- VSDs may be better suited than grid displays for
  - Infants
  - Toddlers
  - Younger preschoolers
  - Older beginning communicators with severe disabilities
- Compared to traditional grid displays, VSDs may
  - Attract more visual attention
  - Result in more accurate performance
  - Support more rapid lexical development /learning
- VSDs are not appropriate for everyone
  - Older preschoolers /school age children require access to traditional orthography
    - to support more advanced language & literacy development

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Why do VSDs enhance the performance of young children?

- Capture contexts in which young children learn language & communication skills
  - Provide visual supports for language learning & use
- Replicate events experienced by the children
  - Support access to language concepts via episodic memory; do not require semantic memory
- Are processed as a whole rather than individual units
  - Reduce working memory demands compared to grids

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Why do VSDs enhance performance of young children?

- Preserve the conceptual & spatial relationships between people & objects as in the real world
  - Preserve proportional size, location, & function
  - Provide greater support for comprehension & use

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Visual cognitive processing of VSDs

(Wilkinson, Light & Drager, 2012)

- VSDs also exploit the human capacity for rapid visual processing of naturalistic scenes
  - Humans process scenes within first glance (Olivia & Torralba, 2007)
    - Humans constantly process scenes in daily life
    - Focus attention on key people/ events
    - Ignore irrelevant background details
    - Presence of context in visual scene does not appear to add visual "complexity"

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What elements should be included in VSDs for young children with CCN?

How can we design VSDs to maximize communication & language development?

Significant variation in the design of VSDs




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Differences in the design of VSDs for young children

- These VSDs differ significantly
  - Presence /absence of humans engaged in social interaction
    - People are a fundamental component of children's early communication experiences
  - Type of image
    - Photos or line drawings
  - Personalization of the scene
    - Personalized or nonpersonalized

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Effects of people in VSDs

(Wilkinson & Light, 2011; Wilkinson & Light, 2014)

- Question
  - What is the effect of people in visual scenes on visual processing?
  - Children with TD, ASD, DS, IDD
- Procedures
  - Presented photos representing visual scenes
  - Used eye tracking research technology to measure where participants looked, when, and for how long

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Results – Visual attention to VSDs

- People in VSDs attracted visual attention within the first 1-1.5s of viewing
  - Results were robust across children with TD, DS, ASD, IDD
- People within VSDs attract much more visual attention than other elements
  - Despite the presence of multiple competing elements in the scene
    - Elements that are large, bright, and/or colorful
  - Even when the people are very small
    - Occupy only 2-5% of the VSD

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Results – Visual attention to VSDs

- Participants look first & longest at people in VSDs, but they also fixate on other elements in VSDs
  - Especially other animate figures
    - E.g., animals
  - Also more prominent, centrally located, meaningful items
    - E.g., Christmas tree, objects with which humans are engaged
  - Viewers typically ignore static non-meaningful background elements
    - E.g., floor, curtains, furniture
  - Key elements of scenes are used to support processing & understanding of scene

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Implications for the design of effective VSDs for young children

- VSDs that include people engaged in meaningful activities
  - Capture the human /social elements that are central to communication development
    - These are the contexts in which language learning occurs
  - Exploit children's innate visual attention to people
- VSDs of empty rooms with no people or stick figures may
  - Fail to capture or focus visual attention
  - Fail to capture the social elements that are integral to communication development

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Constraints of static photo visual scene displays

- Young children with CCN benefit from VSDs to support communication
- Current AAC apps are limited to static photo VSDs; fail to capture dynamic events
- Video offers potential to capture dynamic events but current AAC technologies only support passive video viewing

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Developing technologies with video visual scene displays

- Engineering solution
  - Capture video of daily routines
    - Via built in cameras & wireless import
  - Allow pause of video
    - Create VSDs at these junctures
    - Create hotspots with speech output
  - Initial prototype developed by InvoTek
  - Evaluation studies in progress (stay tuned)

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Future directions for AAC displays for young children (Richtsmeier & Light, 2016)

- Augmented reality (AR)
  - a medium in which digital information is overlaid directly on the real world experience of the individual user (Craig, 2013)
    - Pokemon Go is one example of an AR app
  - AR technologies include
    - Google glas
    - HoloLens, etc.

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Potential AR application for beginning communicators (Richtsmeier & Light, 2016)

- Brother offers child a choice between two different weekend activities
  - Brother says, "Do you want to…", then holds out his right hand and says "hike to the waterfall?",
  - The AR app recognizes the speech and displays the holograph of the waterfall near brother's right hand
  - Brother holds out his left hand and says "or go camping?"
  - The AR app recognizes the speech and displays the holograph of their tent near brother's left hand
- Child expresses him/herself by reaching for the preferred activity, resulting in speech output

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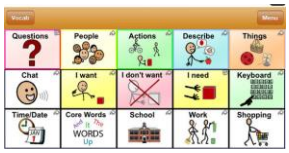
How should we design AAC systems to support **navigation** by young children with CCN?

Navigation

- Traditional AAC systems have utilized separate navigational menus
  - Difficult for young children to understand
  - Requires cognitive map of "hidden" displays
  - Requires understanding that symbol represents an AAC display not a concept



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Alternative designs to facilitate navigation

- Use thumbnails of VSDs for navigation menu
  - Make explicit the link to display
- Include navigation menu on display
  - Limit memory demands
- Animate transition from menu to main communication display upon selection
  - Support conceptual model of navigation
- Model /scaffold navigation for young children initially
  - Do not hold back language development

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Location of navigation menus

- How do navigation menus impact attention
  - minimize distraction during communication
  - maximize accuracy & efficiency during navigation?
- Goal
  - Evaluate effect of menu layouts on visual attention & navigation accuracy & latency
    - Top horizontal, bottom horizontal, right vertical, left vertical
  - Children with ASD, IDD, DS (TD-CA; TD-RLA)

Investigating visual cognitive processing demands of navigation layouts

(O'Neill, Wilkinson, Light & Neumann, 2016)

Children with ASD, DS, IDD

- Procedures
  - Free viewing of VSDs
    - Determine elements of displays that capture visual attention
  - Cued viewing
    - Location of target VSD for navigation

Eye tracking data during cued viewing for participant with Down syndrome

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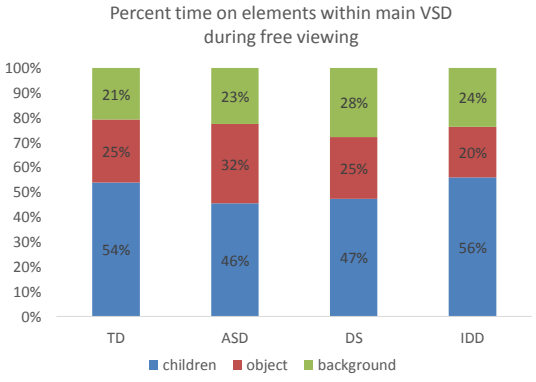
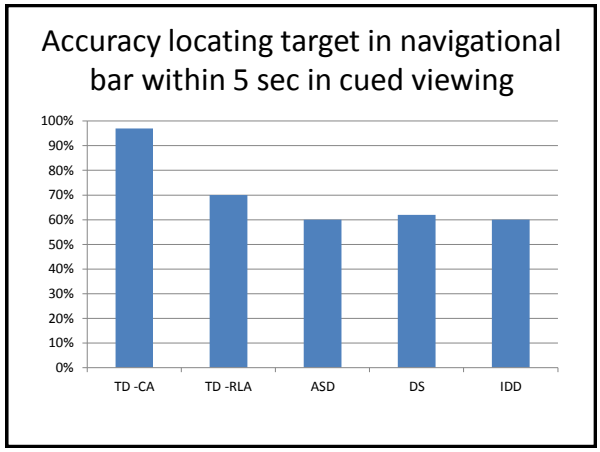


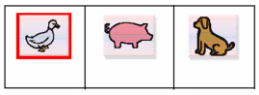


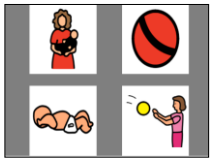
How should we design displays to support **selection** by young children with CCN?

How can we reduce processing demands and maximize accuracy & efficiency?

Traditional approaches to displays: Implications for selection

- Traditionally AAC displays for young children have utilized horizontal rows of symbols or simple grids
- What is the effect of these layouts on selection accuracy and efficiency?





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Effects of target layout on accuracy & efficiency of selection

(Costigan, Light & Newell, 2012)

- Participants
  - 3 year olds & 4 year olds with typical development
- Procedures
  - Required to select targets of various sizes with mouse
    - Horizontal trajectory from start
    - Vertical trajectory
    - Diagonal trajectory
  - Measured accuracy & efficiency of selection

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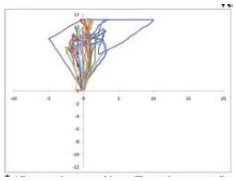
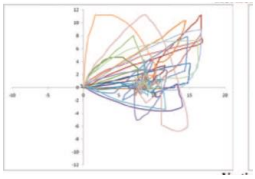
Results & implications for design

Vertical trajectory



Horizontal trajectory



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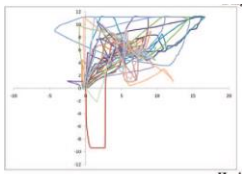
Results & implications for selection

Diagonal trajectory



Implications

- 3 year olds with typical development
  - Were most accurate & efficient with vertical layouts of targets
  - Were less accurate & efficient with horizontal & diagonal layouts of targets

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Implications for designing AAC systems

- Consider vertical layouts of targets at midline for young children and beginning communicators
  - Offering choices
  - Designing early AAC displays

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What about the **output** of AAC systems?

What output will maximize learning and use?

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Output of AAC systems

- Adults typically utilize "motherese" in their interactions with young children
- Child-directed talk
  - Exaggerated intonation
  - Shorter, simpler words & syntax
  - Sound effects
- Benefits of child-directed talk in typical development
  - Captures attention of infants & toddlers
    - Prefer child-directed talk
  - Conveys positive affect
  - Facilitates language learning

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Utilize child-directed speech output

- Reasonable to propose child-directed speech output in AAC systems might have similar benefits for infants & toddlers with CCN
  - Increase appeal of AAC
  - Capture attention to AAC
  - Support understanding
  - Facilitate language learning
    - Vocabulary
    - Syntax
- Limited research on the effects of child-directed speech as AAC output
  - Preliminary evidence suggesting sound effects may facilitate learning of AAC symbols (Harmon, Schlosser, et al., 2014)
  - Part of package AAC intervention that demonstrates positive effects/ difficult to tease out specific effects (Light, et al., 2016)

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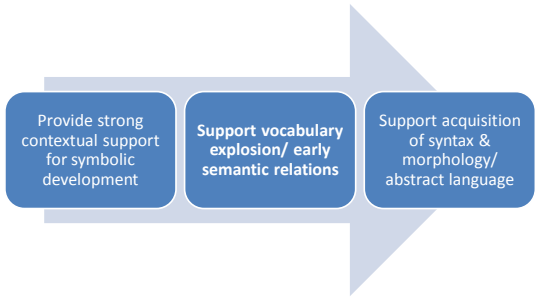
Supporting semantic development



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Semantic development Typical development

- Once children have acquired "first words", they experience a vocabulary explosion
  - Rapidly acquire hundreds of new concepts
  - Learn new words in context
  - Adults scaffold this vocabulary development
    - Respond to children's needs and interests
    - Introduce new words /concepts in context
    - Provide models of use
  - Rich vocabulary is critical to cognitive & language development

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Challenges for children who use AAC

- Young children who rely on AAC face substantial challenges in their vocabulary development
- Current AAC technologies often limit vocabulary learning
  - Difficult & time consuming to program
  - Programming must be completed off line
  - Children are not involved in vocabulary selection

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AAC technology with JIT programming

- What if AAC systems
  - Allow quick & easy import of photos as VSDs
    - Using onboard camera or cell phone with Bluetooth connection
  - Allow quick & easy addition of hotspots and programming of vocabulary
    - Drawing of hotspots with finger or stylus
    - Recording of digitized speech
  - Provide programming controls easily understood & used by young children
  - Support just in time programming of vocabulary

Potential benefits of "just in time" programming

- JIT programming of new vocabulary occurs on the fly within daily interactions in response to child's needs & interests
- Any AAC technology could be used "just-in-time"
  - Provided it is simple & easy to program
- JIT programming
  - Significantly reduces time demands for partners
  - Increases partner responsivity
  - Allows children to be involved in vocabulary selection

With just in time programming, vocabulary development is part of, not separate from, daily interactions

Programming of concepts occurs on the fly during interactions as the need & interest occurs.

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JIT programming - Playing baby dolls

Olivia	**Selects VSD of bathing doll Requests "DOLL" "BATH" Pretends doll is eating soap Shakes her head & vocalizes; laughs**
Nurse	Snaps photo of scene as new VSD
Olivia	Points to soap then doll's mouth on VSD
Nurse	Adds hotspot "SOAP" Adds hotspot "EAT"
Olivia	Shakes her head and laughs
Nurse	Adds hotspot of Olivia shaking her head "NO"
Olivia	Selects "EAT SOAP" Selects "NO" "NO" "NO" and laughs

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Increased motor demands

- With increased vocabulary, come increased motor demands
  - Children may not have isolated point with index finger
- Utilizing adaptive strategies
  - Use thumb to select
  - Allows precision
  - Avoids unwanted selections

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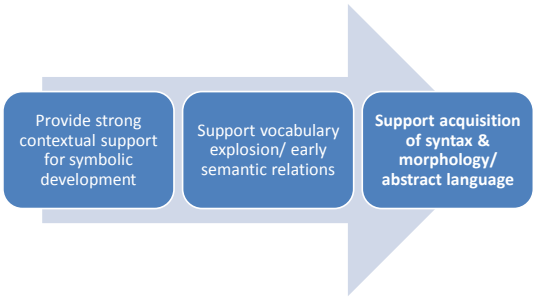
Supporting the acquisition of more advanced language



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Development of syntax & morphology Typical development

- Children without disabilities develop early semantic relations
  - Continue to expand vocabulary
- Build on this foundation and develop more sophisticated syntax / morphology
  - Able to combine concepts to communicate more complex messages
  - Include functors, morphological endings, structural words

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Challenges for children who use AAC

- Development of syntax & morphology very challenging for children who use AAC
  - Often have limited opportunities to communicate complex meanings
    - Messages are co-constructed
    - Partners fill in syntax and morphology
  - Often have limited vocabularies
  - Typically use graphic AAC symbol sets
    - These are semantic systems; not true language systems
  - Often do not have access to morphological markers
    - If they do have access, these have abstract representations and require metalinguistic skills to utilize

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Is there a better way to support the development of advanced language skills?

Supporting the acquisition of advanced language skills

- Children require access to true language system
  - Most logical system is native language
  - Introduce literacy skills
- Literacy skills provide multiple benefits
  - Improved access to education, employment, social interaction, mainstream technology, social media
  - Support for language learning
    - Access to rich vocabulary
    - Visual support for learning syntax and morphology
  - Access to true generative capacity of language

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Current AAC technologies /apps

- Children who require AAC typically use AAC systems/ apps with graphic symbols
  - E.g., Grid displays with PCS, Symbolstix, etc.
  - Minspeak icons
  - Visual scene displays, etc
- These systems/ apps do not support the transition from graphic symbols to literacy
  - Static presentation of text
  - Displaced presentation of text in message bar

AAC technologies to support the transition to literacy (T2L)

- AAC apps that support the transition to literacy (T2L)
  - Individual selects a picture symbol from AAC display
  - Written word appears dynamically
  - Written word is spoken by the app
- 2 apps
  - Grid-based T2L app developed by Saltillo (Hershberger)
  - VSD T2L app developed by InvoTek (Jakobs)
    - Incorporated into SnapScene by TobiiDynavox

Investigating AAC technologies to support transition to literacy

- 9 studies in progress
  - With children & adults with ASD, IDD, CP
  - Using grid-based & VSD T2L apps
- Preliminary results demonstrate positive effect of app on literacy skills for individuals with CCN
  - With minimal exposure to written words

Potential future augmented reality apps to support literacy learning (Richtsmeier & Light, 2016)

- Jason looks at his environment, in this case a child playing with trucks
  - AR app displays text paired with relevant people, objects, actions, events, etc.
- Jason expresses himself by selecting the written words displayed as an overlay in his environment, resulting in speech output
- As his mother or the other child talks, the AR app
  - recognizes the speech & displays the written text adjacent to the referent within the environment
- AR app with written text provides a means to
  - augment input
  - enhance expression
  - support language development
  - increase literacy learning

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Provide literacy instruction to maximize language development (Light & McNaughton, 2009)

- Technology is not enough
- Young children with CCN also require literacy instruction
  - Start early
  - Use motivating & meaningful materials
  - Target appropriate skills
    - Letter sound correspondences, phonological awareness, decoding/ encoding, sight word recognition, shared reading/ writing, etc.
  - Utilize effective instruction
    - Model, guided practice, independent practice
    - Provide numerous opportunities to apply skills in meaningful contexts
  - Provide adaptations to support participation
    - Alternative response modalities
    - Oral scaffolding support
    - Visual supports

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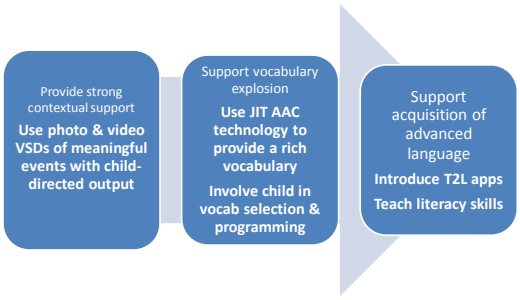
Use literacy skills to bolster speech, language, & communication

- Use written language to
  - Support speech development
    - Letters as visual supports
    - Letter sound knowledge
  - Support language development
    - Build more complex communication
      - Expand semantic, syntactic, morphological, discourse dev't
      - Provide visual support of text; highlight relevant language
  - Foster social interaction
    - Shared reading, texting, social media, etc

AAC systems to support young children's language & communication



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Conclusions

- We have a growing body of evidence that shows that AAC interventions can have positive effects on communication, language & literacy skills
  - Demonstrates the possible
- We have not yet determined how to optimize AAC interventions
  - Current AAC systems /interventions impose significant learning demands
  - They may constrain the rate & scope of language, literacy, & communication as a result

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Research priorities

- Future research is urgently required to
  - Determine visual, cognitive, language & motor processing /development of children with CCN
  - Design & evaluate AAC systems that respond to children's needs across development
    - Are developmentally appropriate
    - Are easy to learn and use
    - Are dynamic
    - Are appealing and fun
    - Provide access to the magic and the power of language and communication

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The future challenge

- Ensure that children with CCN have access to the tools that they require
  - to maximize their communication, language, & literacy outcomes
  - to achieve their full potential

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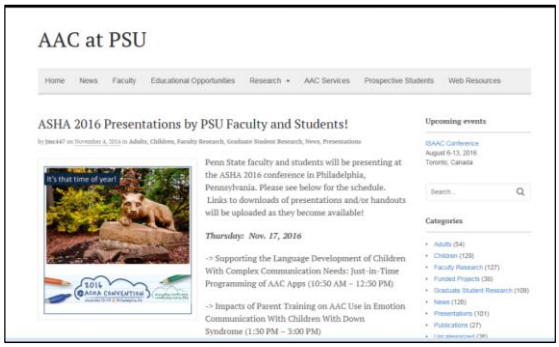
For handouts, visit http://aac.psu.edu



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