

## Designing effective visual scene displays for young children with complex communication needs

Janice Light, Kathryn Drager & Krista Wilkinson  
Communication Sciences & Disorders  
Penn State University

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## Potential of AAC technologies

- Infants, toddlers & preschoolers with CCN are at significant risk in all aspects of their development
  - They require access to language & communication as early as possible to improve outcomes
- AAC technologies /apps offer the potential to enhance communication & language development
  - Unfortunately this potential has not yet been fully realized for young children with CCN
    - One contributing factor is the **lack of AAC technologies /apps that are appropriate for young children with CCN**

## Lack of attention to the design of AAC technologies

- Lack of attention to the design of AAC technologies/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

## Effects of the design of AAC displays

- One of the most important components of AAC technologies /apps is the display
- If AAC displays are well designed,
  - They will enhance communication & language outcomes for young children with CCN
- BUT if AAC displays are poorly designed,
  - They may impede the communication & language development of young children with CCN

## An “ah ha” moment

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



## The current situation

- Most AAC systems are designed by middle-aged European American adults without disabilities
  - The displays reflect perspectives of these adults
- Young children with CCN have very different perspectives /experiences due to differences in
  - Age /development
  - Cultural /ethnic background
  - Disability status

## The design challenge

- As a result, young children with CCN may not find AAC displays
  - Appealing
  - Easy to learn or use
- The challenge
  - How do we design AAC displays that
    - Are easy to learn and use?
    - Appeal to young children with CCN and their peers?

## Goals for session

- Share the results of a series of studies
  - Focused on infants, toddlers & preschoolers
    - Goal was to “get inside their heads”
- Discuss implications for the design of more effective AAC displays for young children with CCN
  - Appeal to young children and their peers
  - Are easy to learn and use

## Decreasing the learning demands for young children



## How should we represent & display language for young children with CCN?

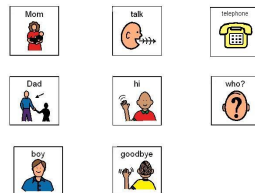
How do we map the internal developing language system of children with CCN to the external AAC display?

## 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 symbols often relies on semantic memory
- Each representation must be processed separately, understood, & then integrated

### Grid for "playing telephone"



## How do young children represent/ display language concepts?

(Light, Worah, Bowker, Drager, Burki, D'Silva, Kristiansen, Jones, & Hammer, 2012)

- 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 & talk about their drawings
  - Shown PCS for concepts & asked to name PCS

## Big

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



## Children's representation of “big”

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

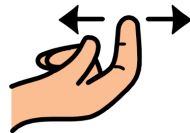


“This is me. I'm big and I'm pushing my brother.”

(5 year old; African American)

## Come

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

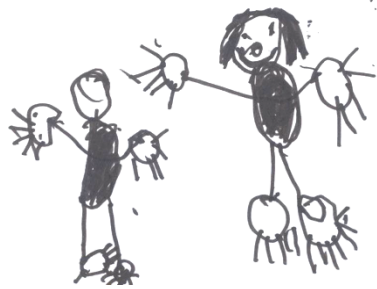


## Children's representation of “come”



“A person calling another ‘come,’ with hand out.”

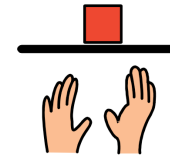
### Children's representation of "come"



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

### Want

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

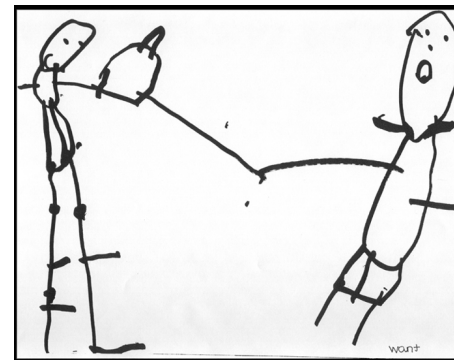


### Children's representation of "want"



"That's the mom, that's the boy, and he wants something."

### Children's representation of "want"



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

## 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



## Children's representation of "who"



“Who's that?’ he says to him. Hands out.”

## Children's representation of "who"



“Girl says, ‘Mom, who is that?’  
‘This is your new daddy.’”

## Results & implications for designing AAC displays

- Young children do **not** initially understand traditional AAC symbols used to represent early emerging abstract language concepts
- This lack of understanding
  - Slows down rate of language learning
  - Adds additional extraneous instructional demands
    - Teach language concept
    - AND teach representation /symbol

## Results & implications for designing AAC displays

- Young children represent language concepts in very different ways than traditional AAC symbols
  - Reflect very different underlying conceptualizations
  - Include depictions of entire scenes or events
    - Concepts are embedded in context
    - Include familiar people and events
  - Seldom include parts of objects or people
    - Requires inference of the complete object/ person & intent
  - Do not include emblems or arbitrary symbols
    - E.g., arrows, movement lines, punctuation
- Results seem to be robust across different cultural groups

## 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”



## 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 ½ years old)
  - Preschoolers (4 & 5 year olds)

## 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 displays for each context
    - E.g., PCS grid vs. photo VSD
    - Position & order counterbalanced
  - Eye tracking technology
    - Measure visual attention / interest



### 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

Mean length of viewing, VSD vs grid

Display Type	Mean length of viewing
PCS grid	~0.5
VSD	~1.7

### Research on the effect of type of display

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



## What does research tell us?

- Toddlers were more accurate locating vocabulary using VSDs than grid displays (Drager, Light, et al., 2003)
- 4 & 5 year olds performed with similar accuracy locating vocabulary using VSDs or grid displays (Light, et al., 2004)



## What does research tell us?

- 4 & 5 year olds performed much more accurately with VSDs or grids than with iconic encoding (Light, et al., 2004)
- With appropriate intervention, preschoolers with CCN can acquire basic literacy skills
  - Require access to traditional orthography (Light & McNaughton, 2009)



## Results /implications for designing AAC displays for young children

- Results suggest that VSDs may be better suited than grid displays for
  - Infants
  - Toddlers
  - Younger preschoolers
  - Other beginning communicators (under age 4 - 5 developmentally)
- Compared to traditional grid displays, VSDs
  - Attract more visual attention
  - Result in more accurate performance
  - May support more rapid lexical development /learning

## Potential benefits of VSDs for young children with CCN

- Well designed VSDs
  - Capture the familiar social interactions that are the contexts in which young children learn language & communication skills
    - VSDs replicate these contexts within the AAC technology/ apps & provide visual supports for language learning & use
  - Replicate events actually experienced by the children
    - VSDs support access to language concepts via episodic memory
    - VSDs do not require reliance on semantic memory

## Potential benefits of VSDs for young children with CCN

- Well designed VSDs
  - Present language concepts within familiar event schema
    - VSDs provide more contextual support for children's comprehension of the representations of these concepts
  - Preserve the conceptual relationships & visual relationships (i.e., proportional size, location) between people & objects as in the real world
    - VSDs provide greater support for children's comprehension & use

## Visual cognitive processing of VSDs

(Wilkinson, Light & Drager, in press)

- Well designed VSDs also exploit the human capacity for rapid visual processing of naturalistic scenes
  - Humans process scenes within first glance (Olivia & Torralba, 2007)
    - Presence of context in visual scene does not appear to add visual "complexity"
    - Visual scenes "chunk" the elements in the scene together
      - » May thereby reduce working memory demands

## Implications of the results

- For young children at the early stages of language development,
  - AAC technologies /apps that utilize VSDs are powerful tools
- However, VSDs are **not** appropriate for everyone
- At later stages of development, children require access to AAC technologies that
  - Support more advanced language & literacy development
  - Provide access to traditional orthography

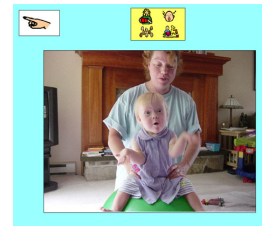
What elements should be included in VSDs for young children with CCN?

## The current situation

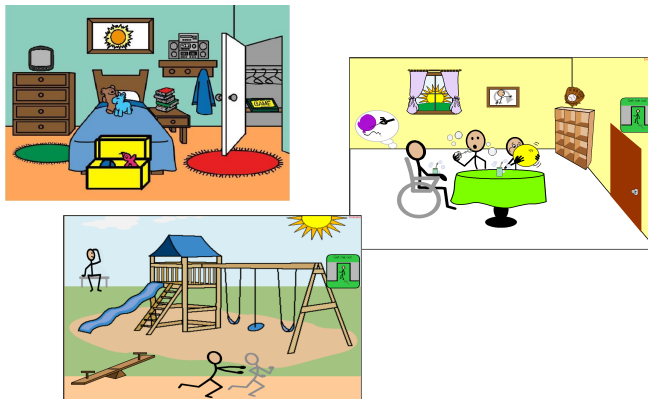
- Currently there are many different renditions of VSDs available for young children
  - Significant variation across AAC manufacturers
  - Significant variation across clinicians

## Examples of VSDs

(from Light & Drager; <http://aackids.psu.edu>)



## Examples of VSDs from AAC Manufacturers



## Differences in the design of VSDs for young children

- These VSDs differ significantly across a number of variables, including
  - Presence of humans engaged in social interaction
    - People are a fundamental component of children's early communication experiences, yet many of the available VSDs do not include people
  - Type of image
    - Photo or line drawing
  - Personalization of the scene
    - Personalized or nonpersonalized

## What elements in VSDs attract visual attention?

(Wilkinson & Light, in progress)

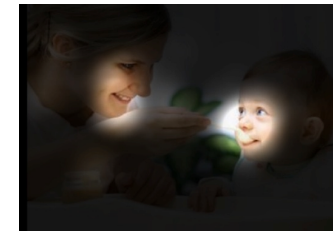
## Viewing patterns

(Light areas indicate where participants looked most;  
dark areas where they looked least)

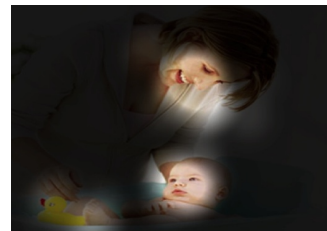
Original VSD



Viewing pattern



## People in scenes have a powerful effect on visual attention



## What is the effect of people in visual scenes on visual attention /processing?

(Wilkinson & Light, 2011)

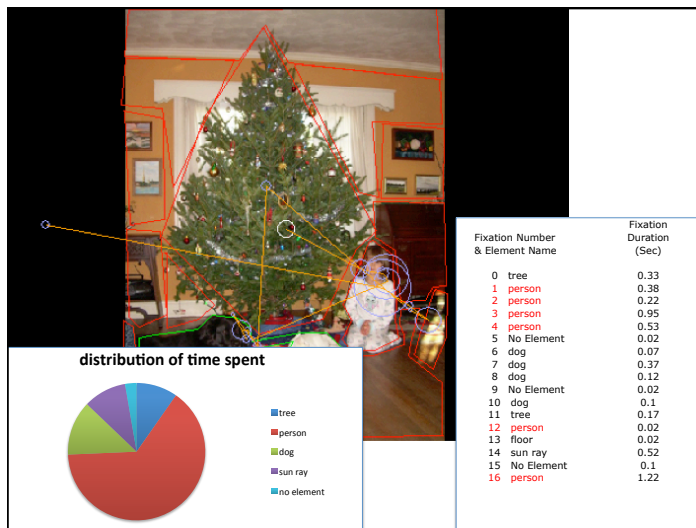
## Effects of people in VSDs

(Wilkinson & Light, 2011)

- Questions
  - What is the effect of people in visual scenes on visual attention /processing?
- Procedures
  - Presentation of photos representing visual scenes
    - Chosen for research purposes; not necessarily appropriate as VSDs
  - Eye tracking technology used to measure where participants look and for how long
    - Measures of visual attention /interest

## Data on participant gaze

white circle is start; yellow lines mark path; purple circles mark focus  
(red lines represent boundaries between elements)



## Results & implications for design of effective VSDs

- People in VSDs attract visual attention within the first second of viewing
- People attract more visual attention than other element within VSDs
  - 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

## Results & implications for design of effective VSDs

- Viewers 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
  - Viewers typically ignore static nonmeaningful background elements
    - E.g., floor, curtains, furniture
  - Key elements of scenes used to support processing & understanding of scene

## Implications for the design of effective VSDs for young children

- VSDs that include people
  - Exploit children’s innate visual attention to people
  - Capture the human /social elements that are central to communication development
- VSDs of empty rooms with no people
  - Fail to capture or focus visual attention
  - Fail to capture the social elements that are integral to communication development

## Effects of personalization & image type of VSDs

- Research questions
  - Effect of type of image on visual attention of infants
    - Preliminary results suggest strong visual preference for photos compared to line drawings by infants at “first words” stage
      - Wilkinson & Light, in progress
  - Effects of personalization & type of image on comprehension and use of VSDs by toddlers
    - Comparison of personalized photo VSDs, nonpersonalized photo VSDs, nonpersonalized line drawing VSDs
      - Drager, Light, Currall, Balberchak, McMillan, & McSweeney, in progress

## Enhancing the appeal of AAC displays

- It is not enough to just consider the learning demands of AAC displays
  - Also need to consider their appeal
- If AAC displays are appealing,
  - Young children will be more likely to use them
    - More opportunities to learn language & develop communicative competence
  - Peers will be more apt to interact with young children who use AAC
    - More opportunities to develop friendships
    - More opportunities to test communicative competence

## How do we enhance the appeal of AAC displays?

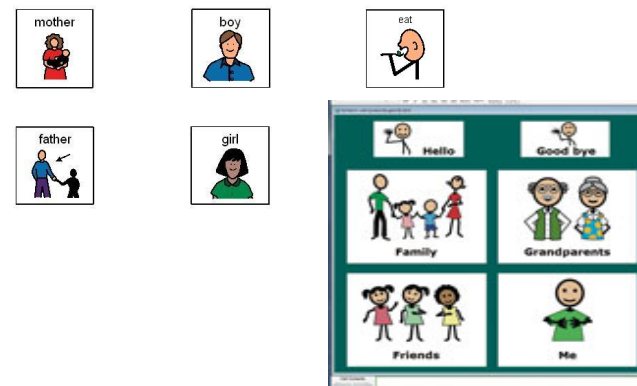
### Research on enhancing the appeal of AAC displays

- Lessons from the toy manufacturers
  - Light, Drager & Nemser (2004)
  - Compared features of AAC technologies to those of popular, award winning toys
- Children's ideas for the design of AAC technologies
  - Light, Page, Curran, & Pitkin (2007)
  - Participatory design involving children
    - Groups of children asked to develop an invention for a young child with speech and motor impairments

### Results & implications for enhancing the appeal of AAC technologies/apps

- Ensure displays infuse communication within children's activities
  - Opportunities for social interaction, companionship, play, games, entertainment, art, music, etc
  - Children should not have to choose between play and communication
- Include multiple bright glossy colors
- Include engaging people /characters in the displays
  - Animated facial expressions

### Traditional AAC symbols used in displays



## Characters that appeal to children

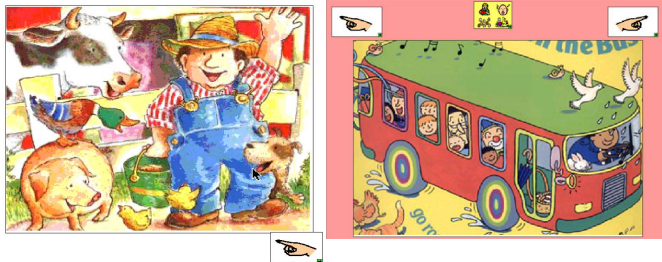


## Results & implications for enhancing the appeal of AAC displays

- Incorporate engaging output into AAC displays
  - Vocabulary that promotes social interaction
    - Hurray!, oh oh!
    - Questions e.g., what's that?, why?
  - Music
    - Songs, instruments
  - Library of sound effects
    - Animal sounds
    - Imaginative play sounds e.g., cars, Star Wars
  - Range of voices
    - Play characters e.g., Elmo
    - Emotions e.g., laughter, crying, raspberry sound



## Examples of AAC displays that appeal to preschoolers



## Summary

### Effective design of AAC technologies /apps

- Research suggests following guidelines for design of effective AAC technologies /apps for young children
  - AAC technologies should appeal to young children
    - Infuse communication into children's activities
    - Incorporate bright colors
    - Include engaging people & characters
    - Include engaging vocabulary & output
  - AAC technologies should be easy to learn and use
    - Use appropriate vocabulary, selection techniques & output
    - Use appropriate representations and layouts



### Evidence-based principles for effective design of VSDs for young children

- Research supports initial use of VSDs with infants & toddlers with CCN /older beginning communicators
- These VSDs should
  - ✓ Include **people** in a prominent position
    - Engaged in meaningful **events /social interactions**
  - ✓ Represent **familiar personalized** events from the child's life
    - ✓ Utilize photos as images
  - ✓ Represent events that are **motivating** for child
    - Be appealing to the child

### VSD requirements for children vary at different ages /stages

- Early stages of development
  - Require simple, motivating, engaging VSDs of familiar activities
  - Include single hotspot with appropriate language and engaging output
- As children learn language
  - Increase number of hotspots
  - Add a range of vocabulary concepts

### From research to practice

- Basic research suggests it is most appropriate to initially introduce young children with CCN to AAC technologies /apps that utilize VSDs
  - Easy to learn and use
  - Appeal to young children
- But does this research translate to improved outcomes in practice with young children with CCN?

What are the effects of intervention using VSDs on the language & communication development of young children with CCN?

## Research study

(Light & Drager; see <http://aackids.psu.edu>)

- Single subject multiple baseline design
- Children with developmental disabilities
  - infants & toddlers at risk for speech development
    - cerebral palsy, Down syndrome, etc
  - presymbolic or minimally symbolic at baseline
    - 0-25 symbols expressively
- Evaluated effects of AAC intervention on children's
  - Communicative turns / participation
  - Vocabulary / semantic development
  - Complexity of messages

## Research on the effects of early AAC intervention using VSDs

- All of the infants & toddlers with CCN
  - Were able to use AAC technologies with VSDs upon initial introduction after minimal modeling
  - Demonstrated significant increases in their rate of turn taking
  - Used VSDs to communicate a range of functions
    - Social routines & expressions
    - Comments
    - Expression of needs and wants

## Research on the effects of early AAC intervention using VSDs

- The children
  - used their AAC systems independently for play & learning as well as communication with others
    - Developed the foundation for learning many preschool concepts
      - e.g., colors, numbers, letter sounds
  - used their systems as shared contexts to support interaction with peers
    - Shared books, singing, play
  - demonstrated significant increases in their expressive vocabularies
  - acquired a range of semantic relations

## The future

- We are at a crossroads in the development of AAC technologies /apps
  - Proliferation of mobile technologies that are readily available to consumers
- But, we have not yet realized the full potential of AAC technologies /apps for young children with CCN
  - Continue to run apps with designs from the 1980s & 1990s on 21<sup>st</sup> century technologies
- Urgent need for new innovative AAC technologies / apps that reflect sound scientific knowledge

### The future challenge

- To develop a new generation of AAC technologies that allow young children with CCN to realize the magic and power of language and communication
- This new generation of AAC technologies / apps must....

### Have real “smile value”



### Be as easy to use as Velcro



### Offer incredible power of language and communication



For further information, visit <http://aackids.psu.edu>



**Early Intervention**  
for young children with autism, cerebral palsy, Down syndrome, and other disabilities

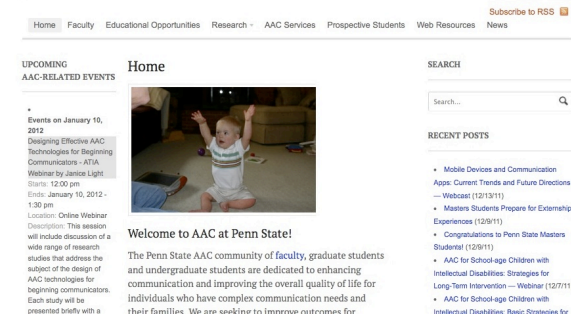
Home  
Success Stories  
FAQ  
Step 1: Identify Contexts  
Step 2: Provide Effective Means  
Step 3: Select Appropriate Vocabulary  
Step 4: Set Up the Environment  
Step 5: Use Interaction Strategies  
Summary of Intervention

**Home**  
What is the purpose of this website?  
This website provides guidelines for early intervention to maximize the language and communication development of young children with special needs including:  
• Infants  
• Toddlers  
• Preschoolers  
The website provides guidelines for early intervention specifically designed for children with complex communication needs, including children with:  
• Autism spectrum disorders  
• Cerebral palsy  
• Down syndrome  
• Multiple disabilities

And also visit <http://aac.psu.edu>

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Events on January 10, 2012  
Designing Effective AAC Technologies for Beginning Communicators - ATIA Webinar by Janice Light  
Starts: 12:00 pm  
Ends: January 10, 2012 - 1:30 pm  
Location: Online Webinar  
Description: This session will include discussion of a wide range of research studies that address the subject of the design of AAC technologies for beginning communicators. Each study will be presented briefly with a

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The Penn State AAC community of faculty, graduate students and undergraduate students are dedicated to enhancing communication and improving the overall quality of life for individuals who have complex communication needs and their families. We are seeking to improve outcomes for

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- For further information, contact Janice Light ([JCL4@psu.edu](mailto:JCL4@psu.edu)), Kathy Drager ([KDD5@psu.edu](mailto:KDD5@psu.edu)) or Krista Wilkinson ([KMW22@psu.edu](mailto:KMW22@psu.edu))