Supporting the language development of children with complex communication needs: Just in time programming of AAC apps

Janice Light, Jessica Caron, Christine Holyfield, Kathryn Drager, Jessica Currall, Clark Knudtson, Merissa Ekman, & Beth Breakstone
Communication Sciences and Disorders
Penn State University
http://aac.psu.edu for handouts
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Challenges for children with complex communication needs

- In contrast, young children with complex communication needs typically
  - Have access to only a limited number of language concepts
  - Communicate for a limited range of intents
    - Typically to express needs and wants
  - Do not have access to new vocabulary immediately as the need or interest arises
  - Have limited control /involvement in vocabulary selection

Magic & power of language development

- During the first 2 years of life, typically developing children make a remarkable transition
  - from birth
    - preintentional and presymbolic
  - to toddlerhood
    - express a wide range of intents
    - acquire hundreds of vocabulary concepts

Limitations of current AAC technologies

- AAC technologies are often difficult for young children to learn & use
  - Children's rate of language learning is slowed by the operational demands
  - Children are not actively involved in vocabulary selection/ programming because of the complexity

Limitations of current AAC technologies

- Maintaining & programming AAC systems adds demands to families & professionals who are already juggling many responsibilities
  - Children's language learning is limited if new vocabulary is not added regularly
  - Families & professionals cannot capitalize on teachable moments during daily interactions

Changing the paradigm

How can we better support young children with CCN in their language learning?

Language and communication outcomes for children with CCN

- Most young children with CCN
  - Start intervention late
  - Start out behind their peers
  - Rapidly fall further and further behind their peers
- But it doesn't have to be this way….

Goals of the session

- To introduce a new approach to AAC intervention & technologies to maximize the language development of young children with CCN
- To present results of research to investigate the impact of this new paradigm
- To discuss implications to enhance language development with young children with CCN

New approach to AAC Intervention

- Start **as early as possible**
- Provide **access to rich language** to support learning
- **Add new vocabulary "just in time"** to AAC systems during interaction in response to child's interests & needs
- **Involve children in vocabulary selection & programming** during daily interactions

Potential advantages of AAC technologies with JIT programming

- JIT programming
  - Significantly reduces time demands for programming
  - Increases partner responsivity
  - Allows partners to capitalize on teachable moments
  - Allows children to be involved in vocabulary selection

What is "just in time" programming?

- JIT programming 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, & quick to program**

Visual scene display (VSD) apps that support JIT programming

- Young children with CCN benefit from visual scene displays
- Visual scene displays (VSDs)
  - Photos of meaningful events within the child's life
  - Relevant vocabulary concepts are programmed as hotspots within the VSDs

Potential advantages of VSDs
(Light & McNaughton, 2012)

- VSDs represent familiar events and activities
  - replicate the contexts in which children learn language
- Language concepts are presented in context
  - provide support for understanding & use
  - support access to language via episodic memory
- VSDs preserve conceptual & visual relationships between people & objects that occur in life
  - preserve the location, function, proportionality of concepts
- VSDs provide motivating & interesting contexts
  - stimulate interaction
- VSDs also offer visual processing advantages
  - regularly process scenes visually within daily life
  - rapidly process scenes

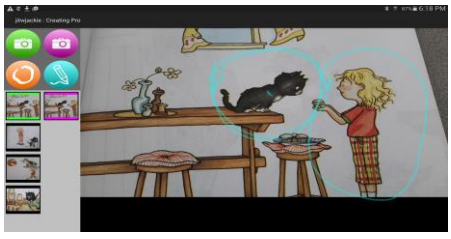
Development of VSD apps that support JIT programming

- We hypothesized that the positive effects of VSD apps would be increased if they supported JIT programming
- In order to support JIT programming, VSD apps must reduce the number & complexity of programming steps
  - Allow quick & easy import of photos as VSDs
    - Using onboard camera or cell phone with Bluetooth connection
  - Allow quick & easy addition of hotspots & programming of vocabulary
    - Drawing of hotspots with finger or stylus
    - Recording of digitized speech
  - Provide programming controls easily understood & used by young children to support their involvement

Impact of visual scene displays

- Research demonstrates that young children with CCN
  - Are able to use VSDs to participate in social interactions immediately after modeling their use
  - Demonstrate significant increases in their participation /turn taking as a result of early intervention utilizing VSDs
  - Demonstrate significant increases in their expressive vocabularies
    (Light & Drager, 2012; Light, et al., 2016; Light et al., 2016)

EasyVSD developed by InvoTek /Jakobs



Research to investigate the impact of VSD apps that support JIT programming

- Study 1
  - compare the time required to program VSDs and vocabulary across 3 VSD apps to determine if JIT programming is feasible
- Study 2
  - investigate the effects of AAC apps on JIT programming by professionals during interactions with young children
- Study 3
  - explore participation in JIT programming by toddlers with typical development
- Study 4
  - investigate the effect of AAC app with JIT programming on communication and language development of young children with CCN

Participants /Procedures:

- 10 adults participated
  - No prior experience in programming the AAC apps
- Procedures
  - No training
    - Provided with step by step written instructions
  - Completed three different programming tasks with each app
- Within subjects design with repeated measures
  - IV = app condition (AutisMate, GoTalk Now, EasyVSD)
  - DV = programming time
  - Order of apps counterbalanced across participants
    - Control order effects

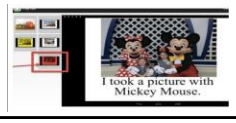
Study #1: Time to program VSD apps

(Caron, Light, Breakstone, & Drager, 2016)

- Research objectives
  - To investigate ways to simplify programming demands of AAC technologies for young children
  - To compare the time required to program VSDs and vocabulary across 3 apps to determine if JIT programming is a viable option
    - AutisMate (SpecialNeedWare)
    - Go Talk Now (Attainment)
    - EasyVSD (InvoTek)

3 Programming Tasks:

- 1. Time to program one visual scene with two hotspots on first exposure to the app
- 2. Time to program a different visual scene with two hotspots on second exposure to the app
- 3. Time to program a three-page linking story with one hotspot per page



Results:
Average programming times across tasks

	AutisMate	GoTalk Now	EasyVSD
Task 1:	3:49	2:38	2:00
Task 2:			
Difference between 1 & 2:			
Task 3:			

Results:
Average programming times across tasks

	AutisMate	GoTalk Now	EasyVSD
Task 1:	3:49	2:38	2:00
Task 2:	2:37	1:31	1:04
Difference between 1 & 2:	1:23	1:07	0:56
Task 3:			

Results:
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Difference between 1 & 2:	1:23	1:07	0:56
Task 3:	4:37	3:40	2:10

Study #1 - Implications of results

- Clinicians and parents with no prior experience would be able to add 5 new VSD with 10 concepts
  - In approximately 5 min using EasyVSD
  - In approximately 7 min using Go Talk Now
  - In approximately 12 min using AutisMate
- Reducing the complexity of programming should support
  - Increased programming of VSDs & vocabulary
  - Increased opportunities for language learning by young children with CCN
  - Potential for just in time programming during interactions with young children

Study #2: JIT programming by professionals

(Caron, Light, & Drager, 2016)

Research objectives

- To investigate the effects of AAC apps on JIT programming by professionals during interactions with young children
- Specifically to compare the effects of 2 apps on:
  - Number of VSDs added JIT
  - Number of vocabulary hotspots added JIT during interactions with young children
  - Engagement of young children
  - Participation of young children in JIT programming

Will JIT programming work in real life interactions with young children?

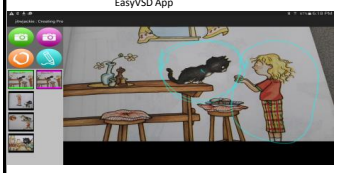
Will partners be able to manage the demands of JIT programming during interactions?
Will young children remain engaged during JIT programming?

Study #2 - Participants

- **Adults (N=8):**
  - Ages 24-56 (M= 45)
  - Experience working with individuals with complex communication needs
    - Range 3-33 years; M= 19.37
  - No prior programming knowledge in GoTalk Now or EasyVSD
    - 6 currently using tablets with kids with CCN
- **Children (N=2):**
  - Twin boys; 3.7 years old
  - No communication, vision, or hearing impairments

Study #2 - Materials

EasyVSD App



GoTalk Now App

Study #2 - Results

- **Number of visual scene displays**
  - In the 10-min interaction, professionals programmed an:
    - Average of 2 visual scene displays in GoTalk Now
    - Average of 4.25 visual scene displays in EasyVSD
- **Child Engagement**
  - Momentary time sampling was used to record if child engagement was observed at a pre-set interval of 10 sec during the 10-min interaction. Children were on task:
    - 84% of the time with GoTalk Now and participated in programming an average of 1 time per session.
    - 93% of the time with EasyVSD and participated in programming an average of 7 times per session.
- **Consumer Satisfaction Survey**
  - All participants (100%) found EasyVSD the easiest app to learn and use with a child in an interaction

Study #2 - Procedures

- **Part 1:**
  - Self Training
  - 3 minute video
  - "Check out"
- **Part 2:**
  - 10 minute interaction using the application and storybook
  - Survey once both apps are used

Study #2 - Implications

- **Implications for practice:**
  - Communication partners face many challenges in their interactions with children with CCN because they must balance the demands of the AAC devices while interacting and responding to the child
    - Just-in-time programming ensures that children have access to the personally relevant, meaningful vocabulary that they need and want immediately during their interactions
    - JIT programming also provides a way to involve children in vocabulary selection

Study #2 - Implications

- **Implications for technology development:**
  - Most AAC systems require offline programming of new vocabulary because programming involves multiple steps.
  - Develop AAC apps with only necessary customization features in order to optimize efficiency, reduce learning demands, and increase appeal

Study 3: Research Objectives (Holyfield et al., in press)

- The goal of this study was to describe typically developing toddlers' participation in the AAC programming process
- Successful participation was credited to toddlers based on their completion of each individual programming step

1. Select "photo" icon
   - Activating screen within ¾ in icon diameter
2. Touch anywhere on screen to take a photo
   - Timing activation with desired environmental content
3. Select "hotspot" icon
   - Interpreting the representation's meaning
4. Trace around area of photo to make a hotspot (does not have to be a closed shape)
   - Identifying desired area
5. Select "record" icon
   - Use of an isolated point
6. Speak to record the hotspot output
   - Producing speech

- Optionally:

1. Select "draw" icon
   - Discriminating between icon functions
2. Trace with finger anywhere to draw on the VSD
   - Activating screen within VSD boundaries

Are young children able to participate in JIT programming of VSDs and vocabulary?

What are the developmental demands of JIT programming?

Study 3: Participants

- 10 typically developing toddlers participated
- The toddlers' ages ranged from 10 months to 22 months (mean=16 mo.)
- Motor information:
  - All toddlers demonstrated an isolated point
  - All toddlers coordinated gaze and movement
- Cognitive-linguistic information:
  - All toddlers demonstrated joint attention skills
  - All toddlers communicated symbolically
  - 8 of 10 toddlers used spoken words

Study 3: Materials

- The EasyVSD app on a Samsung tablet containing an onboard camera
- Storybooks that were naturally available in the toddlers' home and/or daycare setting (depending on the setting in which the sessions occurred)

Study 3: Results

- All 10 toddlers were able to participate in programming in some capacity, with overall rates of successful participation at 41%, out of an average of 80 opportunities
- However, there was a great deal of variation in participation success across the toddlers who participated and the steps of the programming process

Study 3: Procedures

- Each toddler completed three, 10-min sessions
- In each session, the toddler and investigator participated in shared storybook reading, guided by the toddler's interests
- After the toddler chose an initial book, the investigator modeled the entire programming sequence once at the beginning of each session
- Throughout the storybook reading, the investigator supported the toddler in programming storybook pages using a least-to-most prompting hierarchy
  - 4 s wait time
  - Verbal prompt (e.g., "Tell the computer you want to take a picture")
  - Visual prompt (e.g., pointing at the "Photo" icon)
  - Model (e.g., selecting the "Photo" icon, then navigating back to provide the toddler another opportunity)

Study 3: Results

Percentage of successful participation for each toddler out of total opportunities for participation in each programming step

Participant; age in months	Selecting photo icon	Taking a photo	Selecting hotspot icon	Creating a hotspot	Selecting record icon	Recording message	Selecting draw icon	Drawing on photo	*Mean* (SD)
1; 10 months	11	67	0	11	0	0	0	67	*20*(30)
2; 11 months	0	50	0	0	0	0	0	80	*16*(31)
3; 12 months	10	70	0	10	0	10	0	50	*19*(26)
4; 13 months	0	80	0	0	0	0	0	70	*19*(35)
5; 14 months	27	100	18	0	0	0	18	82	*33*(39)
6; 18 months	100	90	80	30	70	0	80	90	*68*(35)
7; 19 months	30	40	10	10	20	0	30	90	*29*(28)
8; 20 months	82	91	45	45	18	9	91	100	*60*(35)
9; 21 months	80	100	70	80	30	10	90	100	*70*(32)
10; 22 months	90	100	70	70	60	0	100	90	*73*(33)
Mean (SD)	*48*(40)	*79*(22)	*29*(33)	*27*(29)	*20*(26)	*3*(5)	*41*(44)	*82*(16)	*46*(28)

Study 3: Implications for Practice

- Although the study did not focus on children who require AAC, results suggest that theoretically-driven AAC technology and clinician support can allow children who are in very early stages of motor, cognitive, and linguistic development to participate meaningfully in the AAC programming process
- However, some aspects of programming may be more demanding than others, so clinicians should tailor their level of support for each programming step based on the relationship between:
  - The motor, linguistic, and cognitive demands of the step, and
  - The motor, linguistic, and cognitive profiles of the child

Study #4 – Evaluation with children with CCN

(Light et al., 2016)

- Research objectives
  - To investigate the effect of AAC app with JIT programming on:
    - Number of communicative turns taken by young children with CCN
    - Number of unique vocabulary concepts expressed
    - Amount of vocabulary available for communication
  - To investigate generalization & maintenance of effects in home/ day care environments
- Single case multiple probe across participants

How will AAC JIT app affect communication & language of young children with CCN?

Will parents and teachers be able to incorporate the app into daily interactions with children with CCN?

Participants

- 5 children participated
  - 15-33 months old at start of study
  - Developmental delay
    - Down syndrome, PDD-NOS, rare chromosomal disorder resulting in motor & intellectual impairments
    - 1 child experienced medical issues during study
  - Had complex communication needs
    - Speech inadequate to meet their communication needs
  - Were beginning communicators
    - Signs, low tech systems, visual schedules
    - Were not using SGDs at the time of the study

Study 4 - Procedures

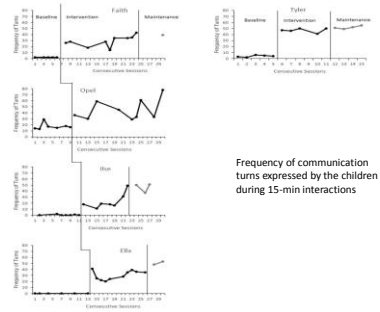
- Data collected during 15-min play interactions in homes /day care
  - Primary caregivers involved in all phases
- 3 phases
  - Baseline prior to intervention
    - Use of typical modes of communication
  - Intervention
    - Introduction of the AAC app with JIT programming
  - Generalization /maintenance at home or day care
    - Parents /early intervention teams were
      - Provided with 10-30 min training in AAC JIT app
      - Responsible for programming & implementation with child

Generalization & maintenance of turn taking at home & daycare

- Only 4 children completed maintenance /generalization
  - 1 child was hospitalized and unable to continue
- The other children maintained /increased frequencies of turn taking with AAC JIT app during maintenance /generalization
  - Mean of 50 turns in 15 min during maintenance/ generalization
    - Range of 39-55 turns across children
  - Mean gain of +48 turns from baseline to maintenance /generalization with JIT AAC app at home /daycare
    - Range in gains of +37 to +53 turns in 15-min interactions across children

Results - Effects of AAC JIT app on children's turn taking

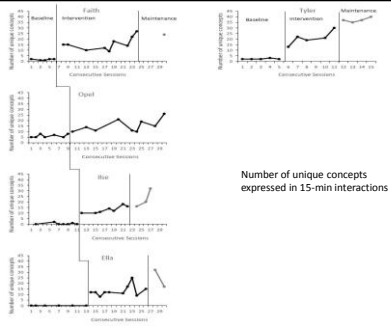
- Children had low rates of communication at baseline
  - Mean of 0 – 17 turns across children in 15 min interactions at baseline
- Children took significantly more turns during intervention with the AAC JIT app
  - Mean of 23-47 turns across children in 15 min interactions during intervention
    - Mean gain of +22 to +42 turns in 15 min interactions with AAC JIT app
  - % nonoverlapping data
    - 100% for 4 of children; highly effective intervention
    - 89% for 1 child; effective intervention despite medical issues



Frequency of communication turns expressed by the children during 15-min interactions

Results - Effects of AAC JIT app on unique concepts communicated

- Children expressed limited range of concepts at baseline
  - Mean of 0 – 6 unique concepts expressed in 15 min interactions at baseline
- Children expressed significantly more unique concepts during intervention with AAC JIT app
  - Mean of 13-21 unique concepts expressed across children in 15 min interactions during intervention
    - Mean gain of +9 to +19 unique concepts expressed in 15-min interactions
  - % nonoverlapping data
    - 100% for all 5 children; highly effective intervention



Number of unique concepts expressed in 15-min interactions

Unique concepts expressed during generalization & maintenance at home & daycare

- Children demonstrated significant increases in number of unique concepts expressed during maintenance /generalization at home or daycare
  - Mean of 17-40 unique concepts expressed across children in 15 min during maintenance/ generalization
  - Gain of +17 to +38 unique concepts expressed from baseline to maintenance /generalization at home /daycare

JIT programming - Playing baby dolls

Olivia	Playing dolls; drops doll
Nurse	Makes crying sound; picks up doll & kisses the doll Olivia laughs
Olivia	Points to image of nurse kissing on VSD
Janice	Adds hotspot "KISSING" + sound effect
Olivia	Selects "KISSING" and laughs Points to nurse
Nurse	Kisses doll Olivia laughs
Janice	Writes "k" on display to foster early literacy skills in meaningful context Adds hotspot with letter sound

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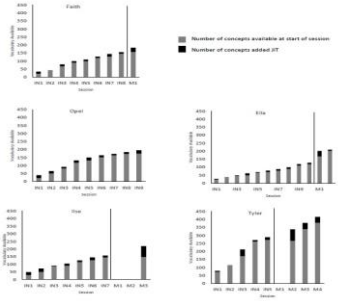
Results – Amount of vocabulary available to children

- Children had access to significantly more vocabulary concepts during intervention with the AAC JIT app
  - After 5-10 intervention sessions, children had access to
    - Range of 156 - 289 concepts across 75 - 94 VSDs /contexts
- Parents & professionals continued to add vocabulary regularly during generalization /maintenance at home or daycare
  - Mean of +18 vocabulary concepts added by parents /professionals per week for the children
    - Range of +7 to +32 concepts added across children per week

Implications

- Demonstrates the advantages of AAC apps that support JIT programming
  - Fewer programming steps required
  - Vocabulary added regularly by typical partners
  - Increased responsivity of partners during interactions
- Demonstrates positive effects of AAC JIT app on communication of young children with CCN
  - Increased turn taking of children
  - Increased number of unique concepts expressed
- Demonstrates children's involvement in selecting & programming vocabulary
  - Empowered in language development



Extension to natural environments

- These positive effects extend to
  - Use by parents / professionals
  - In natural environments at home or daycare
  - With only minimal technical training required
    - 10-20 min of informal training

Limitations

- Results would be strengthened with
  - Additional replications across more participants
    - Different ages and disabilities
  - Longer term evaluation in home, school, daycare environments
  - Evaluation of long term effects on language learning

New paradigm in AAC Intervention

- Start **as early as possible**
- Provide **access to rich language** to support learning
- **Add new vocabulary "just in time"** to AAC systems during interaction in response to child's interests & needs
- **Involve children in vocabulary selection & programming** during daily interactions

Conclusions

- Exciting paradigm shift for the field
  - Supports early intervention with infants & toddlers
  - Allows capture of meaningful events in their lives as they occur
    - Allows partners to respond immediately to children's interests
  - Provides access to vocabulary immediately as needed
    - Allows partners to capitalize on teachable moments
  - Reduces programming demands on clinicians & families
    - Supports regular programming of new vocabulary concepts
  - Supports children in selecting & programming vocabulary in AAC apps
    - Empowers children in language learning

Impact on children with CCN

- With paradigm shift, parents & clinicians will be better able to support
  - Increased participation by children with CCN
  - Increased opportunities for language learning
  - Greater vocabulary growth
  - Increased learning & educational achievement
  - Greater empowerment of children with CCN

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

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Conflict of interest

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