

Update on the
Rehabilitation Engineering Research Center on AAC
RERC on AAC

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T. Jakobs, J. Light, & D. McNaughton



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The need and our response

- There are millions who have severe disabilities resulting in complex communication needs (CCN)
 - Developmental disabilities
 - Acquired disabilities
 - Degenerative disabilities
- Over the past five years the RERC on AAC focused on three areas within AAC
 - UI design for beginning communicators
 - Improving access for communicators with severe physical impairment
 - Creating training resources for families and professionals

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The full success of AAC intervention is best evaluated

by the extent to which it improves access and participation in valued activities and experiences of everyday life.

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- “Sam”
- 21-year old with Down syndrome
- 10% speech intelligibility
- Purchase food in large grocery store

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Participation supports: Video Models



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- "Sam"
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- Purchase food in large grocery store

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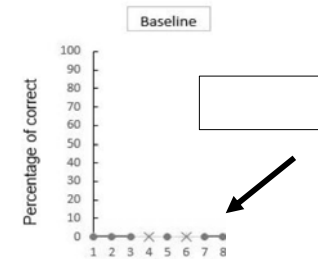
Shopping list

- Ortega Taco shells
- 2 bananas
- Quarter pound of Dietz and Watson American cheese
- Small Yoplait raspberry Yogurt,
- 2 green apples,
- Quarter pound of Weis premium honey turkey



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The Video Visual Scene Display (VSD)



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Video Visual Scene Displays = Video modeling

- Watch the video until a “pause” (still image)
- Cue to perform step



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Video Visual Scene Displays = Video modeling +

- Watch the video until a “pause” (still image)
 - Cue to perform step
- The still image is a *Visual Scene Display*
 - Can be programmed with hotspots
 - When touched, provide speech



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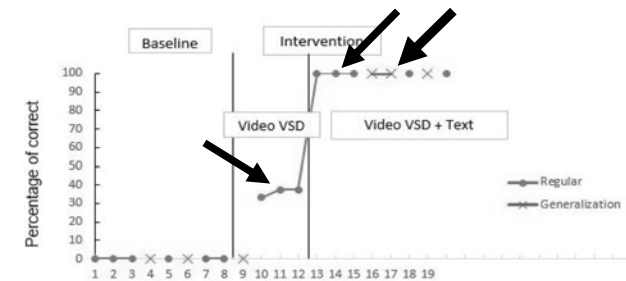
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GoVisual – Attainment



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Saturday, Boca III
– 9:20 - 10:20

Video VSD Tutorial



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Improving access: multimodal access technologies

Meet Amelia...

- 25 years old, 30-inches tall
- Brittle bone disease
- Limited hand control
- Some voice, but impacted by vent
- No single access solution enables her to achieve her potential.
- Could we combine access methods to help her access technology more successfully?

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Improving access: multimodal access technologies

Team

- InvoTek, Inc., Madonna, Penn State, Saltillo

The problem

- For people with severe physical impairment, a single access method...
 - Is fatiguing
 - Requires vigilance and precise motor execution (dwell, scanning)
 - Most access methods require optimal set-up, positioning and environmental conditions to be relied upon exclusively.
- If everything isn't perfect, errors increase.



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Improving access: multimodal access technologies

Created prototype

- Eye tracking + scanning access system

Two clinical areas of exploration

- Study 1: Identify learning associated with using the multimodal prototype.
- Study 2: Comparison of multimodal to single access methods.



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Improving access: multimodal access technologies

Access Strategy

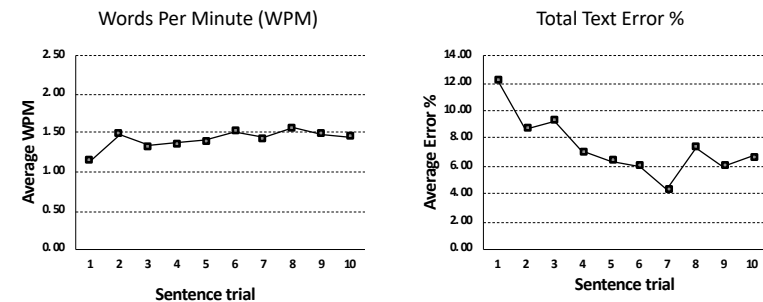
- Eye tracking identifies “cluster” of letters
- When target letter is in the highlighted “cluster”, user activates a switch
- All letters within the “cluster” are then scanned, user activates switch when target letter is reached
- Letter is then inserted into message window



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Improving access: multimodal access technologies

Study 1: Group average (20 people) per sentence trial



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Improving access: multimodal access technologies

Study 2: Multimodal Performance

Research Question

- For literate adults with CCN, does performance differ using multimodal, scanning, and eye tracking?

Method: Alternating Treatment Design

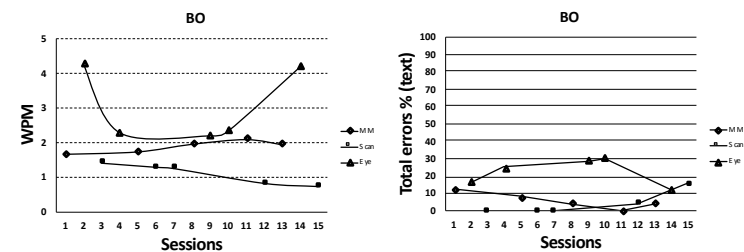
- Random assignment of access method (multimodal, scanning, eye tracking)
- Laboratory setting (optimal positioning)
- Constructing sentences on onscreen keyboard using each approach
- Recruited 6 individuals with physical access challenges



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Improving access: multimodal access technologies

Participant BO (c4 SCI & mild TBI)



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Improving access: multimodal access technologies

Study 2: Multimodal Performance

Problems...

- Analysis ignores errors that don't result in an error in the text window
 - E.g., if a wrong row is selected in scanning, many participants would wait for the scan to complete before trying again- this did not result in a text entry error.
 - How can we capture the "process" or what occurs from an access perspective during the construction of text output?



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Improving access: multimodal access technologies

Study 2: Multimodal Performance

Problems...

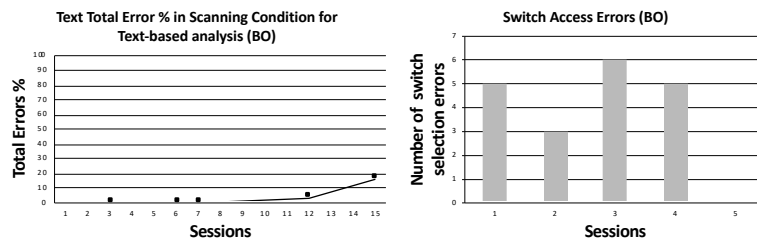
- Errors in access, whether they result in a text entry or not, impact effort, fatigue, satisfaction, perception (e.g., one participant kept commenting how horrible he was at scanning and how much he disliked it)
- Re-evaluate data and count switch selection errors (no switch press, timing error on row, etc.)



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Improving access: multimodal access technologies

Study 2: Multimodal Performance – Quick look at BO's scanning errors



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Improving access: multimodal access technologies

Study 2: Multimodal Performance Conclusions

Multi-input strategy may be more accurate/consistent for some

- Individuals who cannot consistently use eye-tracking alone as an efficient/accurate access method
 - **Eye tracking highly inaccurate or inefficient compared to other less direct access methods**
 - e.g., brainstem stroke with extensive eye motor control issues early in recovery



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Improving access: multimodal access technologies

Study 2: Multimodal Performance Conclusions

Multi-input strategy may be more accurate/consistent for some

- Individuals with emerging eye control not yet sufficient as single access method
 - **Transitional access method**
 - **Bridges the gap between indirect access via switch scanning to direct access via eye tracking**



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Improving access: smart prediction

Meet Billy...

- 28 years old
- Brainstem stroke
- Very little volitional movement
- Partner assisted communication with vertical eye movement
- “No shave November”
- Can we make word/phrase prediction systems contextually aware?



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Improving access: smart prediction

InvoTek team

- Tom Jakobs
- Erik Jakobs

OHSU team

- Melanie Fried-Oken
- Michelle Kinsella
- Rebecca Pryor



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Improving access: smart prediction

Challenge

Using an AAC spelling device to type out messages during spontaneous conversation is very slow and demanding for the person using AAC. Message production rates violate verbal interaction rules, leading to isolation or impoverished communication.

Goal

To increase the speed of message generation in an AAC spelling device and the engagement of communication partners by relying on the knowledge of a partner during conversation.



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Improving access: smart prediction

Research Question

- Will word/phrase predictions from a partner increase partner engagement and enable the person with severe speech and physical impairments (SSPI) to produce messages faster?
- Individuals with SSPI must maintain control over expression.

Targeted Users

- Literate individuals with SSPI who use AAC devices with single switch scanning, and their care or communication partners.



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Improving access: smart prediction

Dual AAC Apps

AAC Interface



Partner Interface

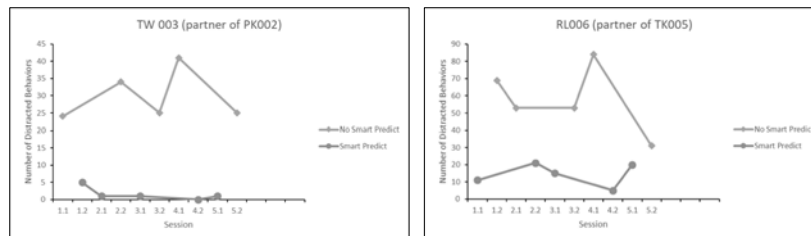


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Improving access: Smart Prediction

Research results

- While speed of communication only improved modestly, partner engagement was much better with Smart Prediction

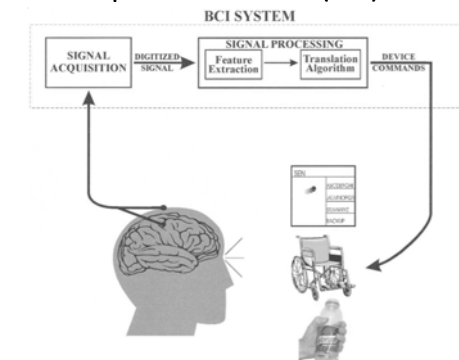


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Improving access: Brain Computer Interfaces (BCI)

Research Question

- BCIs intended for communication require high vigilance and seem to be tiring.
- Can we measure drowsiness over time?



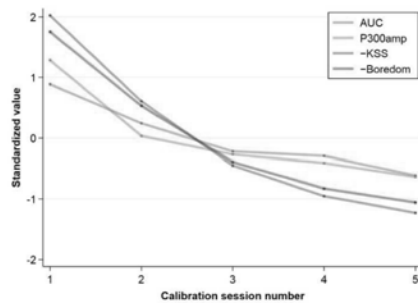
Wolpaw, et al (2002). Brain-computer interfaces for communication and control. *Clinical Neurophysiology*, 113, 767-791

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Improving access: Brain Computer Interfaces (BCI)

Can we measure drowsiness over time?

Results for 20 adults calibrating BCI 5 times consecutively



- Significant declines in performance and P300 amplitude over time.
- Significant increases in sleepiness reported.
- No between subjects effects; individual changes over time may predict performance or P300 amplitude.

Oken, Memmott, Eddy, Wiedrick, & Fried-Oken (in-press) *Brain Computer Interfaces*

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Susie

- 3;10
- Developmental Delay
 - PPVT – 1 %tile
 - EVT – 10 %tile
 - TOPEL Early Literacy Index – 2 %tile
- Importance of literacy
 - Remain in curriculum
 - Communication support
- Lots of goals in preschool
- Embed literacy “instruction” in everyday activities?



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Investigating AAC technologies to support literacy

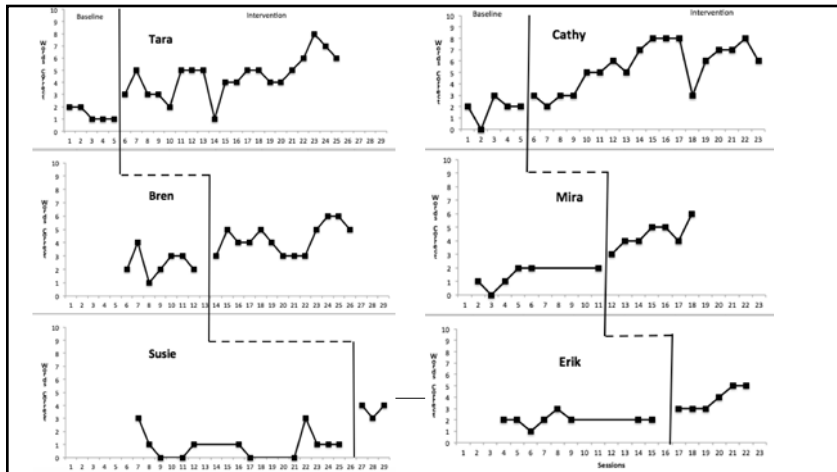
- **Team**
 - Penn State/ InvoTek/ Saltillo
- **The problem**
 - More than 90% of individuals with CCN enter adulthood without literacy skills (Foley & Wolter, 2010)
 - Current AAC technologies do not support the transition from graphic picture symbols to literacy

- **Transition to literacy (T2L)** software feature
 - Individual selects a picture symbol from AAC display
 - Written word appears dynamically
 - Written word is spoken by the app



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- **Transition to literacy (T2L)** software feature
 - T2L apps are intended to **complement**, **not replace** literacy instruction



- 2 apps
 - Grid-based T2L app developed by Saltillo (Hershberger)
 - VSD T2L app developed by InvoTek (Jakobs)
 - Incorporated into SnapScene by TobiiDynavox



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HCI R3: Investigating cognitive processing demands of AAC interfaces

- **Engineering solution**
 - Define display characteristics that affect visual cognitive processing demands
 - Determine optimal designs for AAC displays to maximize communication



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HCI R3: Investigating cognitive processing demands of AAC interfaces

- **Research methods**
 - Series of studies to investigate visual cognitive characteristics with individuals with CCN
 - Eye tracking research methods



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Training & Dissemination

- Professionals (pre-service and in-service)
- Persons with complex communication needs
- Family members



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Challenge



Less than 1 in 10 adults with developmental disabilities
have access to AAC

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Preservice training

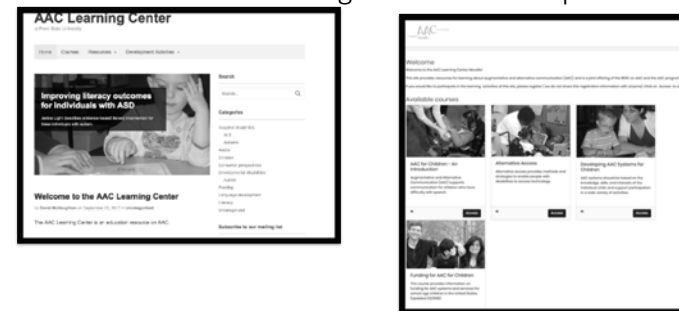
- 18-35% of preservice programs do not offer any coursework at all in AAC
- 54-71% of preservice programs for SLPs do not employ faculty with expertise in AAC
- 64% of programs report that faculty who are not experts in AAC typically teach the AAC courses
- “Voices” of people who use AAC (and family members) are under-represented in AAC educational materials

• Light et al (2014)

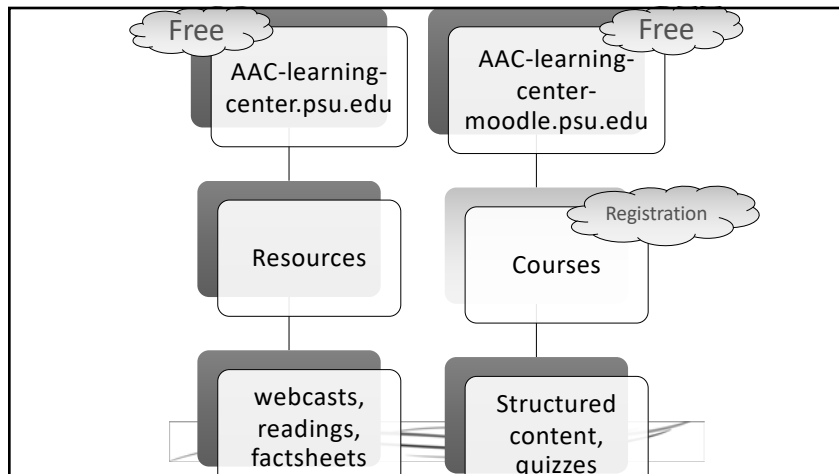


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AAC-Learning-Center.psu.edu
AAC-Learning-Center-Moodle.psu.edu



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AAC-Learning-Center-Moodle.PSU.EDU



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What do the students say? Literacy course (Summer 18)

Learning how to teach literacy skills to a child who has difficulty with speech is important for me in my future work as a professional	strongly agree	agree	no opinion	disagree	strongly disagree
	24	6	1	0	1
	73%	18%	3%	0%	3%
Completing this module ____ my skills in teaching letter sound correspondences to a child with complex communication needs	strongly improved	improved	did not change	worsened	strongly worsened
	16	15	2	0	0
	48%	45%	6%	0%	0%
Would you recommend this module to another person who wants to participate in an online learning module on this topic?	strongly recommend	recommend	no opinion	not recommend	strongly not recommend
	19	13	0	0	1
	58%	39%	0%	0%	3%
The methods used to teach in this on-line lesson were effective for me	strongly agree	agree	no opinion	disagree	strongly disagree
	17	12	3	0	1
	52%	36%	9%	0%	3%

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AAC-Learning-Center.psu.edu



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Building capacity is a “team” effort

- Need to represent the “Voices” of people who use AAC (and family members)

How Far We've Come, How Far We've Got to Go: Tales from the Trenches
November 10, 2019 AAC Learning Center



Chris Klein: Building Relationships through the Tools of Communication
June 24, 2019 AAC Learning Center



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Building capacity is a “team” effort

- Need to represent the “Voices” of people who use AAC (and family members)

The folly of fortune telling
October 14, 2019 AAC Learning Center



The impact of early access to AAC
July 19, 2019 AAC Learning Center



Building a better BC: The value of input from people with needs
October 14, 2019 AAC Learning Center



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Research to Practice: Patient-Provider communication

Advice for AAC Users

- Prepare
- Ask questions
- Create a plan
- Take away information



Burns, M. I., Baylor, C. R., & Yorkston, K. M. (2016). Words of Preparation for Patients: Through a series of simple steps, we can help clients with communication disorders plan ahead to get what they need from medical visits—despite their challenges. *The ASHA Leader*, 21(3), 52-56.

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Challenge: To date limited discussion and research about the cognitive skills demanded of user for AAC technologies.

Goal: To develop a literature resource to help describe the cognitive demands that various features of AAC devices or apps place on the person with complex communication needs

Targeted Users: AAC clinicians and device developers

Current Efforts: Year 5 of the RERC on AAC.

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Thinking about Thinking for AAC

An interactive online source designed to provide summaries from literature in fields of AAC and cognition.



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What Thinking about Thinking for AAC is

A tool to answer: "What does this device or app demand cognitively from the user?"

- Provide literature references about the cognitive demands of specific features of AAC technologies
- Provide opportunity for clinicians to consider and compare the cognitive demands of AAC technologies
- Identify available research gaps that exists regarding the cognitive demands of AAC technologies and apps to guide future directions
- Inform the design of AAC technologies

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Thinking about Thinking for AAC: Two Parts

Part One: An online interactive library

Thinking about Thinking for AAC Home Go to Library Learn More Log In

Library Information

Select the features of the AAC technology and click 'Submit' to view a report of the associated cognitive demands.

Please note: The Cognitive Demands Report may be missing information about the cognitive demands of some of your selected features due to a lack of research literature about those features. If no information is available about a given feature, "No References Found" will appear in the report.

Selected Features

- Access: Indirect Selection: Row-Column Scanning

Cognitive Demands

Access: Indirect Selection: Row-Column Scanning

Attention

- Typically developing children responded with greater accuracy using direct selection as opposed to row-column scanning. Errors increased as a function of task complexity and decreased as a function of age. It was suggested that this is due to the attention demands of the task.
- Mackin, M., Reagle, J., Radloff, A., & Frost, J. (1996). Effects of selection techniques and entry rates on short-term visual memory. *Augmentative and Alternative Communication*, 10(4), 237-244. <https://doi.org/10.1080/07430171231779490>
- Radloff, A. (1990). Comparison of cognitive demands implicated in direct selection and scanning. *Communication Disorders Quarterly*, 13(4), 211-219.

Output

The means by which the device or software produces a message that can be heard or read by the user and communication partners.

Submit

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Cognitive Demands Report

Cognitive Demands placed on the AAC Technology user.

Please note: The Cognitive Demands Report may be missing information about the cognitive demands of some of your selected features due to a lack of research literature about those features. If no information is available about a given feature, "No References Found" will appear in the report.

Generated on Wed Jan 10 10:24:07 PST 2019

Selected Features

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Cognitive Demands

Access: Indirect Selection: Row-Column Scanning

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- The time cost of scanning places extra demands on the child's attention. It is more difficult to remember the intended message and to maintain attention to a task during scanning due to the time spent waiting.
- Radloff, A. (1990). Comparison of cognitive demands implicated in direct selection and scanning. *Communication Disorders Quarterly*, 13(4), 211-219.
- Radloff, A. (1990). Comparison of cognitive demands implicated in direct selection and scanning. *Communication Disorders Quarterly*, 13(4), 211-219.

Part II: Downloadable PDF

Containing an annotated bibliography and a summary of literature findings.

Selected literature references and summaries were generated by multiple members of RERC on AAC team during consensus process.

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<https://tat4aac.ohsu.edu/>

Thinking about Thinking for AAC Home Go to Library Learn More

Thinking about Thinking for AAC (TAT₄AAC)

All humans are learners. Individuals have unique learning profiles. Learning to communicate is a basic human right. Learning to use augmentative and alternative communication (AAC) technology is complex. This online resource provides information by summarizing literature in the fields of AAC and cognition to support clinical decision-making.

For additional information, please visit the Learn More section.

Go To Library

Feedback from the Field

66 I could use [TAT₄AAC] when talking about parents or family members to justify a programming decision (e.g. photographs as a symbolic decision) for an individual's AAC device. 91

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State of the Science



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AAC Doctoral Student Think Tank Penn State University: 2017, 2019, 2021



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Outcomes of the RERC on AAC to date

- Initiated **over 20** new research studies to advance knowledge and improve outcomes for individuals with CCN
- Developed **5** new engineering solutions to advance AAC technologies and improve outcomes for individuals with CCN
- Mentored over 100 students in our labs, including 65 engineering students and 35 rehab scientists
 - **11** of these students recognized with national /international awards
- Over 45 peer-reviewed publications

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Dissemination rerc-aac.org



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The full success of AAC intervention is best evaluated

by the extent to which it improves access and participation in valued activities and experiences of everyday life.

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RERC-AAC.ORG

- We are grateful to all of the individuals who use AAC and their families who have contributed to the RERC on AAC.
- The contents of this presentation were developed under a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant number #90RES017) to the Rehabilitation Engineering Research Center on Augmentative and Alternative Communication (RERC on AAC).
- NIDILRR is a Center within the Administration for Community Living (ACL), U.S. Department of Health and Human Services (HHS). The contents of this presentation do not necessarily represent the policy of NIDILRR, ACL, HHS, and you should not assume endorsement by the Federal Government.



RERC on AAC

