RERC on AAC: Overview of Research, Development and Training Objectives

M Fried-Oken
S Fager
T Jakobs
D McNaughton

RERC on AAC

ATIA 2016 Session Number AAC-37

The partners

1. **InvoTek, Inc.**
   + Tom Jakobs, co-Investigator
2. **Madonna Rehabilitation Hospital**
   + Susan Fager, co-Investigator
   + David Beukelman, co-Investigator
3. **Oregon Health & Science University**
   + Melanie Fried-Oken, co-Investigator
4. **Pennsylvania State University**
   + Janice Light, Principal Investigator
   + David McNaughton, co-Investigator

The need

- 4+ million Americans with severe disabilities resulting in complex communication needs
  - Developmental disabilities
  - Acquired disabilities
  - Degenerative disabilities

The challenge

- Many individuals with CCN are severely restricted in their participation in society
  - Education
  - Employment
  - Health care
  - Family
  - Community living

Our vision

- Ensure that <u>all</u> individuals, including those with the most complex needs, have access to effective AAC technologies to realize
  - the basic human need,
  - the basic human right, and
  - the basic human power of communication

RERC on AAC

Research

- Access R1: Brain-computer interface (BCI) with enhanced language modeling
- LangTech R2: Technologies to support the transition from graphic symbols to literacy
- HCI R3: Visual cognitive processing demands of AAC interfaces

Development

- Access D1: Multimodal technologies to improve access
- LangTech D2: AAC technology to support interactive video visual scene displays
- LangTech D3: AAC technology with smart prediction
- HCI D4: Cognitive demands checklist for AAC technologies and apps

Training

- Mentored research and lab experiences, AAC webcasts and MOOC, AAC Incubator (Rehab Engineering Capstone and Hack-a-Thon) , RESNA Student Design Competition, Doctoral student Research ThinkTank

Dissemination

- Website, webcasts, YouTube channel, e-blasts, presentations, publications, consumer publications, blogs, technical assistance , exhibit booth, State of the Science conference

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Our rehabilitation engineering & science team

Principal Investigator
Janice Light

Lifespan Strand: Research and Development-Children
Janice Light
Tom Jakobs

Access.D1 LangTech.R2
LangTech.D2 HCI.R3

Lifespan Strand: Research and Development-Adults
Melanie Fried-Oken
Steven Bedrick

Access.R1 LangTech.D3
HCI.D4

Training and Dissemination
(Knowledge and technology transfer)

David McNaughton
Pam Kennedy
Godfrey Nazareth

Penn State University

Invotek, Inc.

Madonna Rehabilitation Hospital

Oregon Health & Sciences University

Northeastern University

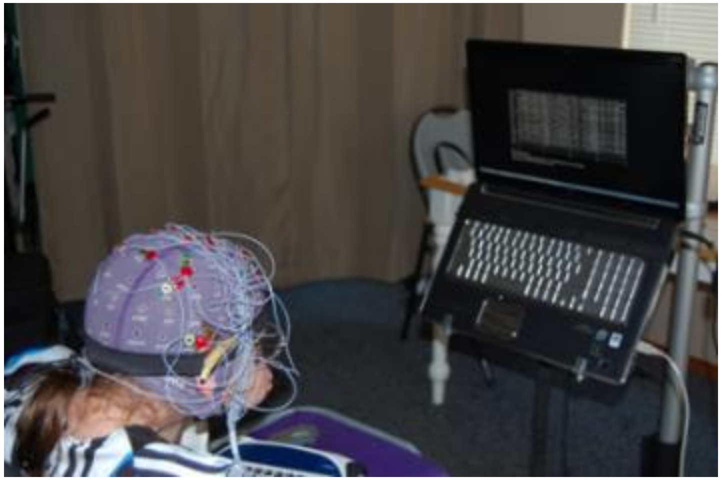
Expert Advisory Board and Key Stakeholders

Collaborations

- Inclusion of individuals with disabilities and family members in all RERC activities
- Active collaborations with AT manufacturers, mainstream industry, professional organizations, IHEs, educators/ rehab professionals & NIDRR funded projects to maximize impact

RERC on AAC
Research projects

Access R1: Investigating brain computer interface



- Team
  - Oregon Health and Science, Northeastern
- The problem
  - Brain-computer interface (BCI) provides a potential means for individuals to control a computer using only their brain waves, but limited information on
    - Use with clinical populations
    - Support for effective use

Access R1: Investigating use of a BCI with enhanced language modeling

HOW BCI WORKS

- You are fitted with an EEG cap that acquires your brain signals. You watch a screen with letters.
- When a letter that you want appears on the screen, your brain wave (the P300 event related potential) changes.
- This is averaged over time and is interpreted as a 'keystroke'.
- A language model confirms that the 'keystroke' is a statistically possible selection.

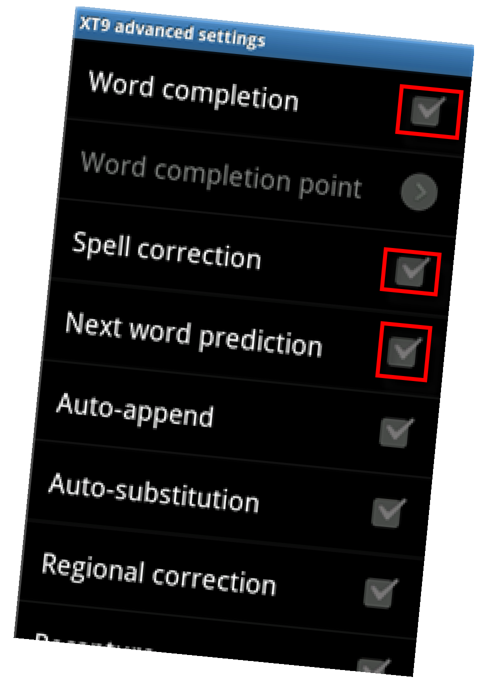
How the RSVP Keyboard™ works

Access R1: The AAC technology problems

- BCI for communication is very slow.
- Spelling with BCI is often inaccurate.
- Language modeling has not been applied to an RSVP spelling paradigm previously.
- It is very difficult to attend to the BCI task for long periods of time.

Access R1:
Engineering solutions

- **Increase speed and spelling accuracy:** Change the language model probabilities and add an autotyping function.
- **Increase attention to the task:**
  - Provide cognitive training programs to people as they learn to use BCI
    - Study 1: Process-specific attention training
    - Study 2: Mindfulness meditation



Language Modeling

- A Language Model (LM) is a way of assigning *probability* to strings of symbols (words, letters, etc.)
- Using a large collection of real-world text, an LM learns patterns of language
- "President of the United ________"
- "FRED WAS Q_"
- Often we think of an LM in terms of conditional probability (Given X, what is the probability of Y)

Access R1: Research hypotheses and design

- **Study 1:** Ps will attain better selection accuracy scores and spelling performance with enhanced LMs.
- **Study 2 and 3:** Ps' selection accuracy and spelling performance will improve after a 6-week training period with either process-specific attention training or mindfulness meditation
- Design
  - Series of single subject experimental designs
    - 5 Individuals each with ALS, spinal cord injuries, brainstem stroke (N=15)

Access R1: Independent and dependent variables; data analysis

Independent Variables

- Study 1: Enhanced language model
- Study 2: Attention training
- Study 3: Mindfulness meditation training

Data analysis

- Comparison of level, trend, slope & variability of data at baseline to intervention

Dependent Variables

- Highest level completed on a copy-spelling task
- Selection accuracy score
  - Correct characters/minute
  - Total error rate

Access R1: Expected outcomes

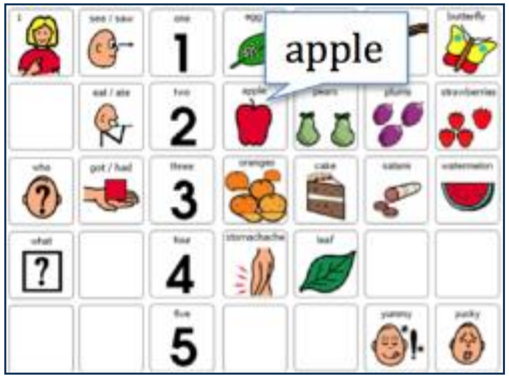
- Increased functionality of RSVP Keyboard™
- Increased user satisfaction with access method
- Reduced workload and fatigue
- Evidence-based attention training programs for all BCI users

Lang Tech R2: 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
  - Current AAC technologies do not support the transition from graphic picture symbols to literacy

Lang Tech R2: Investigating AAC technologies to support literacy

- Engineering solution
  - AAC apps to support the transition from graphic symbols to literacy
    - Individual selects a picture symbol from AAC display
    - Written word appears dynamically next to graphic symbol representation
    - Written word is spoken by the app



Lang Tech R2: Investigating AAC technologies to support literacy

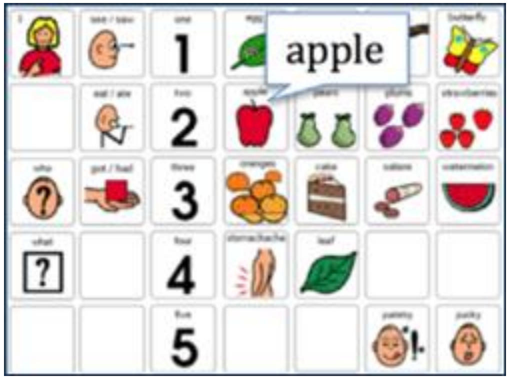
- Research hypothesis
  - Individuals with CCN will increase their literacy skills as a result of using the AAC app
- Design
  - Series of single subject experimental designs
    - Individuals with ASD, CP or IDD

Lang Tech R2: Investigating AAC technologies to support literacy

- Independent variable
  - AAC app to support literacy (grid & VSD)
- Dependent variable
  - Number of written words read accurately
- Data analysis
  - Comparison of level, trend, slope & variability of data at baseline to intervention

Lang Tech R2: Investigating AAC technologies to support literacy

- Progress to date
  - Prototype apps developed
  - Data collection in progress
- Expected outcomes
  - 2 new research-based AAC apps known to improve literacy skills for individuals with CCN
    - Grid-based app
    - VSD-based app



HCI R3: Investigating cognitive processing demands of AAC interfaces

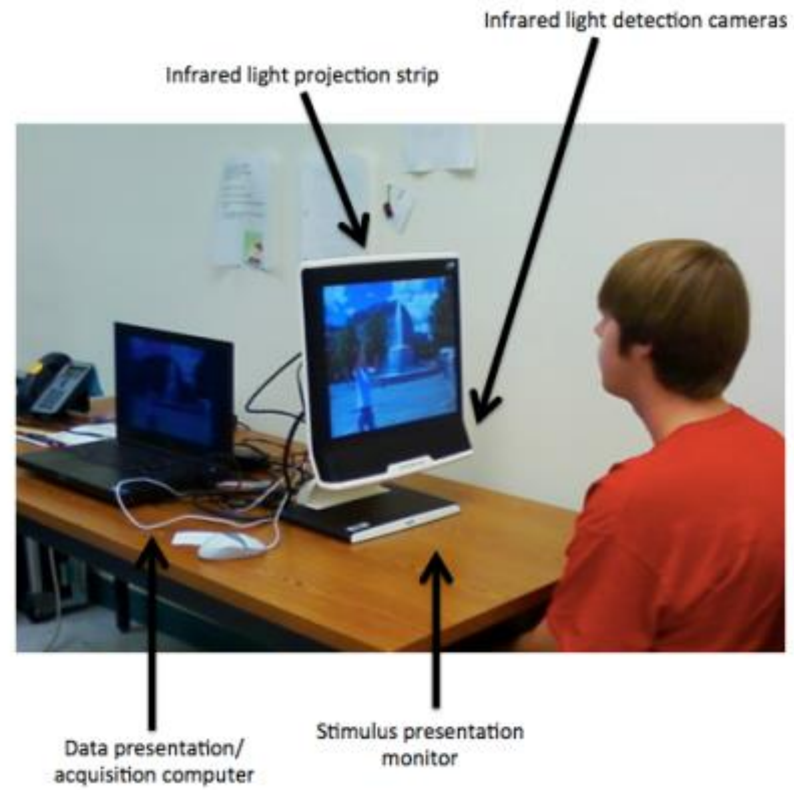
- Team
  - Penn State, Madonna, InvoTek/ Saltillo
- The problem
  - Most AAC displays are <u>not</u> research-based and are poorly designed
    - Impose significant visual cognitive processing demands
    - Impede communication performance

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

HCI R3: Investigating cognitive processing demands of AAC interfaces

- Research methods
  - Series of studies to investigate visual cognitive processing demands of different display characteristics with individuals with CCN
  - Eye tracking research methods



HCI R3: Investigating cognitive processing demands of AAC interfaces

- Eye tracking research technology
  - Rapidly samples position of eye in relation to AAC display
    - Latency of fixation
    - Duration
    - Sequence of visual fixation

HCI R3: Investigating cognitive processing demands of AAC interfaces

- Progress to date
  - Data collection in progress to investigate demands of different navigational layouts
- Expected outcomes
  - Scientifically-based design specifications for AAC displays
    - Minimize cognitive demands & maximize communication

RERC on AAC Development projects

Access D1: Developing multimodal access technologies

- Team
  - InvoTek, Inc., Madonna, Penn State, Saltillo
- The problem
- Focus has remained on single access methods despite advanced in access technologies (eye/head tracking, touch interfaces, specialty switches).
- Challenges with focusing on a single access method
  - Fatigue due to over-use
  - Inefficiency
  - Heavy reliance/focus on methods such as dwell that require vigilance and precise motor execution

Access D1: Developing multimodal access technologies

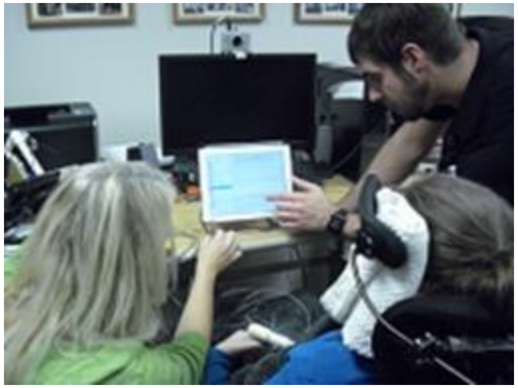
+ Goals of the project
  - Design multi-modal technology so that the best access method is always available.
    - E.g., Use a head tracker with dwell for accessing an onscreen keyboard; use an eye-blink for desktop selections.
  - Min. the shortcomings of an access method.
    - E.g., Use an eye tracking for large cursor movements and head tracking for small, corrective cursor movements.
  - Unintentional movements don't cause errors.
    - E.g., Thumb movement causes a switch closure only when the hand is still.

Access D1: Developing multimodal access technologies

- Engineering solution
  - Develop multi-modal solutions specific to individual with SSPI
  - Develop 3-D movement tracking system capable of measuring eye, head, and gestures (e.g., jaw or finger movement)
    - Proposed system will provide universal access to wide range of computer and smart/mobile technologies
    - SDK (Software Development Kit) to integrate this technology into AAC devices

Access D1: Developing multimodal access technologies – Clinical Evaluation

- **Preliminary Investigations:**
  - Document current multi-modal use by persons with CCN (what technology is used, why, challenges associated, impact on participation)
  - Evaluate custom solutions through case study series



- **Systematic evaluation of movement tracking system**
- 45 participants (15 children with CP, 15 adults with CP, 15 adults with cervical SCI)
- Alternating treatment design (5 single access and 5 multimodal access counterbalanced sessions)
  - Target acquisition task
  - Dependent measures- accuracy, rate and movement across tasks
  - Individual feedback and personal preference/potential benefit of 3-D multimodal system

Access D1: Developing multimodal access technologies

- Progress to date
  - Survey of multi-modal use by individuals with CCN (currently data collected on 5 with SCI, 2 with ALS, and 3 with CP)
  - Case study illustrations:
    - Alison, Tiffany, Cloe
  - Expected outcomes
    - New genre of access technology

Lang Tech D2: Developing technologies with video visual scene displays

- Team
  - Penn State, InvoTek
- The problem
  - Many individuals with CCN benefit from visual scene displays (VSDs)
  - Current AAC apps with VSDs are limited to static photos
  - These static VSDs fail to capture dynamic communication routines

Figure . Child pretending to sleep next to his farm animals in a PlayTalk VSD.

Figure . Hotspot creation on the VSD. The hotspot outlines are only visible when adding hotspots – not during normal use by the child.

Lang Tech D2: Developing technologies with video visual scene displays

- Goals of the project
  - To develop a mobile technology AAC app that supports video visual scene displays
  - To investigate the effects of the video VSD app on communication by individuals with CCN

Lang Tech D2: 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

Lang Tech D2: Developing technologies with video visual scene displays

- Clinical evaluation
  - Series of single case studies
  - Investigate the effects of the video VSD app on the frequency & effectiveness of communication by individuals with CCN

Lang Tech D2: Developing technologies with video visual scene displays

- Progress to date
  - Initial prototype developed
  - Systematic review of potential clinical applications of video VSD
  - Data collection in progress
- Expected outcome
  - New research-based app that supports video VSDs

Access D3: Developing AAC technologies with smart prediction

- Team
  - Oregon Health & Science University, InvoTek, Saltillo
- The problem
  - Communication speed is very slow for people with SSPI.
  - Communication partners have contextual knowledge, but no way to support written AAC message construction.

Access D3: Developing AAC technologies with smart prediction

- Goals of the project
  - Develop a unique AAC system that incorporates the communication partner's knowledge into the AAC device prediction list.
  - The end result:
    - increased speed and informativeness of face-to-face conversations,
    - More control for AAC user in social interactions.

Access D3: Developing AAC technologies with smart prediction

- Engineering solution
  - Develop a unique AAC system that incorporates the communication partner's knowledge into the AAC device prediction list.
  - The end result:
    - increased speed and informativeness of face-to-face conversations,
    - More control for AAC user in social interactions.

Access D3: Developing AAC technologies with smart prediction

- Clinical evaluation
  - The study will evaluate impact of Smart Prediction on conversation (rate, informativeness, satisfaction) compared to standard prediction
  - Testing will occur in the community, in supported employment sites or other community environments in Portland, OR.

Access D3: Developing AAC technologies with smart prediction

- Progress to date
  - Prototype apps have been designed and tested.
  - Initial clinical evaluation is underway.
- Preliminary Results
  - First AAC user:
    - Preferred using the app to her present AAC device.
    - Regulated effort by waiting for partner to complete her prediction suggestions.

Access D4: Developing a Cognitive Demands Checklist for AAC Technologies

- **Team**
  - Oregon Health and Science

- **The problem**
  - Communication technology should be matched to the cognitive needs and abilities of the user
  - Current feature matching tools do not address the cognitive demands of AAC use
  - We have not examined the cognitive demands of AAC technologies and apps

HCI D4: Developing a Cognitive Demands Checklist for AAC Technologies

- Our goal: Develop, evaluate, and distribute the Cognitive Demands Checklist (CDC)
- The CDC will be a valid, reliable tool to:
  - Assist clinicians with person-technology matching
  - Help developers understand the cognitive demands of AAC technologies and design improved products

HCI D4: Developing a Cognitive Demands Checklist for AAC Technologies

- Engineering solution
  - Examine existing AAC devices and software/apps
  - ID requisite cognitive skills and propose checklist items
  - Determine domain and content relevance of items for a range of AAC tech.
  - Launch web-based checklist

HCI D4: Developing a Cognitive Demands Checklist for AAC Technologies

- **Clinical evaluation and testing**
  - Validate checklist content with national AAC stakeholders
  - Revise checklist based on stakeholder feedback
  - Researchers complete checklist for existing AAC technologies to establish intra-rater reliability
  - AAC stakeholders complete checklist for existing AAC technologies to establish inter-rater reliability

HCI D4: Developing a Cognitive Demands Checklist for AAC Technologies

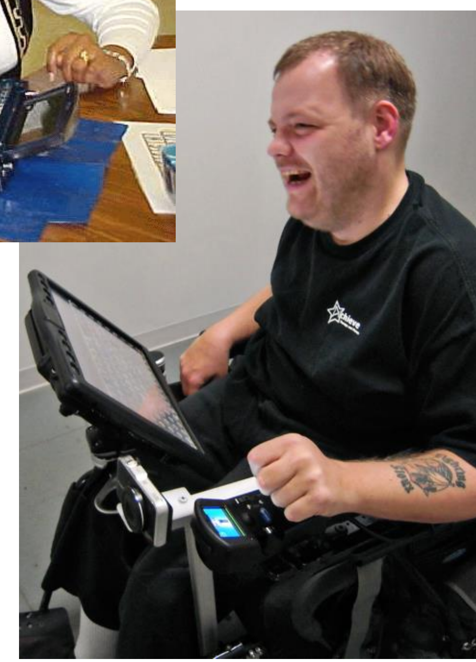
- **CDC tech transfer and distribution**
  - Web-based application
  - Available on multiple websites
  - Free of charge to AAC stakeholders
  - Marketed through AAC stakeholder groups and industry conferences
  - Added to GPII shelf of Raising the Floor Consortium
  - Eventually available in multiple languages and in Braille format
  - Broad accessibility (universal design)

Access D4: Developing a cognitive demands checklist

- Progress to date
  -
- Expected outcomes
  - (addressed in previous slide)

RERC on AAC
Training & dissemination

Training: Challenge (photos)



Experienced

- naive vs experienced

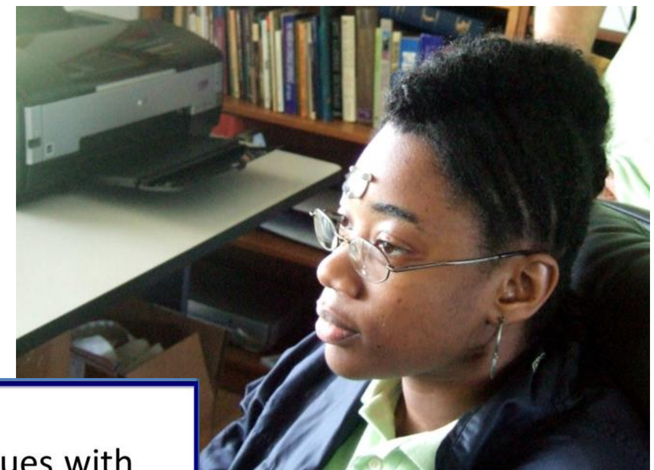
Practicality

- applied vs theoretical

Goals

- Breadth vs depth

T1: Mentored Research and Lab experiences



Merging traditional techniques with iDevices and AAC strategies for Severe Speech Sound Disorders

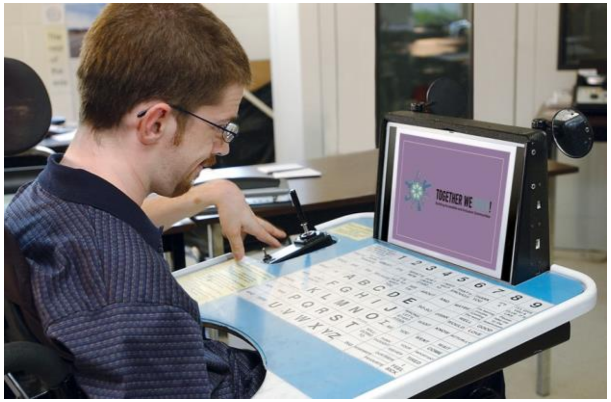
Jessica Gosnell Caron

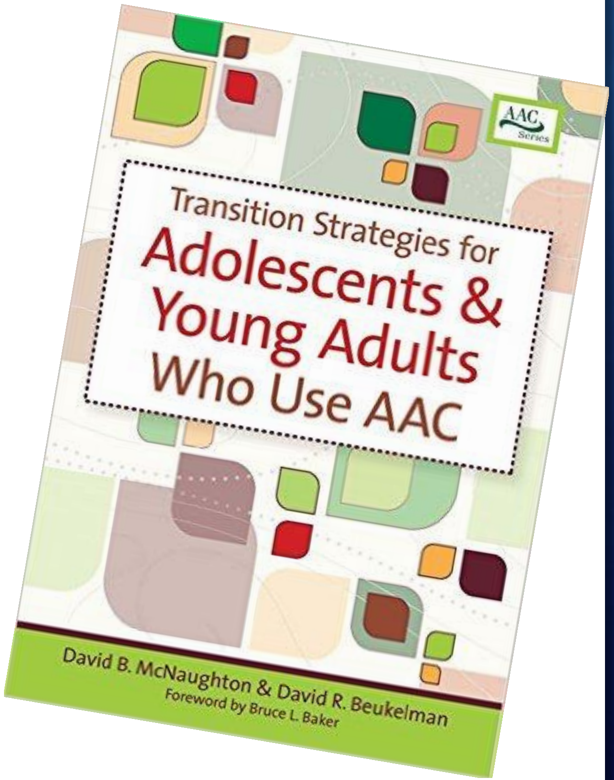
T2) Webcasts & MOOC

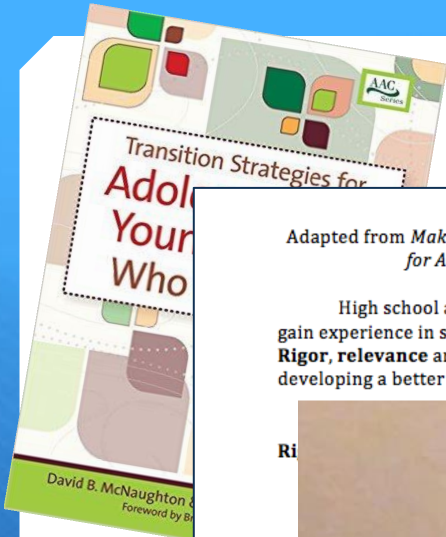
MOOC: Massive Online Open Course

- Modules
  - Early intervention, transition, funding, literacy, access for individuals with minimal movement
- Materials
  - Readings: Open access articles, summaries
  - Webcasts: presentations, “first person”
  - Activities: Answers to FAQs, think/pair/share
- Assessment
  - Quizzes, AAC materials
    - CEUs, course credit (at home institution)

Transition




AAC Series
Transition Strategies for
Adolescents &
Young Adults
Who Use AAC
David B. McNaughton & David R. Beukelman
Foreword by Bruce L. Baker



Adapted from *Making School Matter: Supporting Meaningful Secondary Experiences for Adolescents Who Use AAC (Carter and Draper, 2010)*

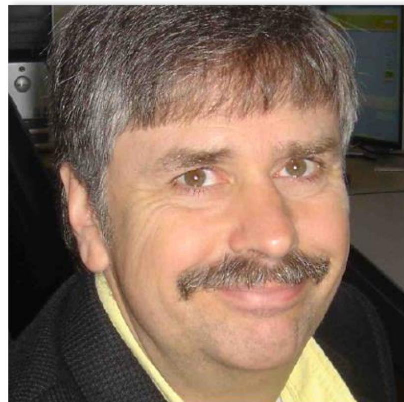
High school and middle school are important for students with disabilities to gain experience in skills that will later support them after they graduate high school. **Rigor**, **relevance** and **relationships** are three terms that are necessary in developing a better experience for students with disabilities.

Ri

Training & Dissemination: Rehabilitation Engineering & Science team

Mary Frecker

Tom Jakobs



Chris Klein

David McNaughton

Godfrey Nazareth

T3) AAC Incubator

Focus groups of persons who use AAC

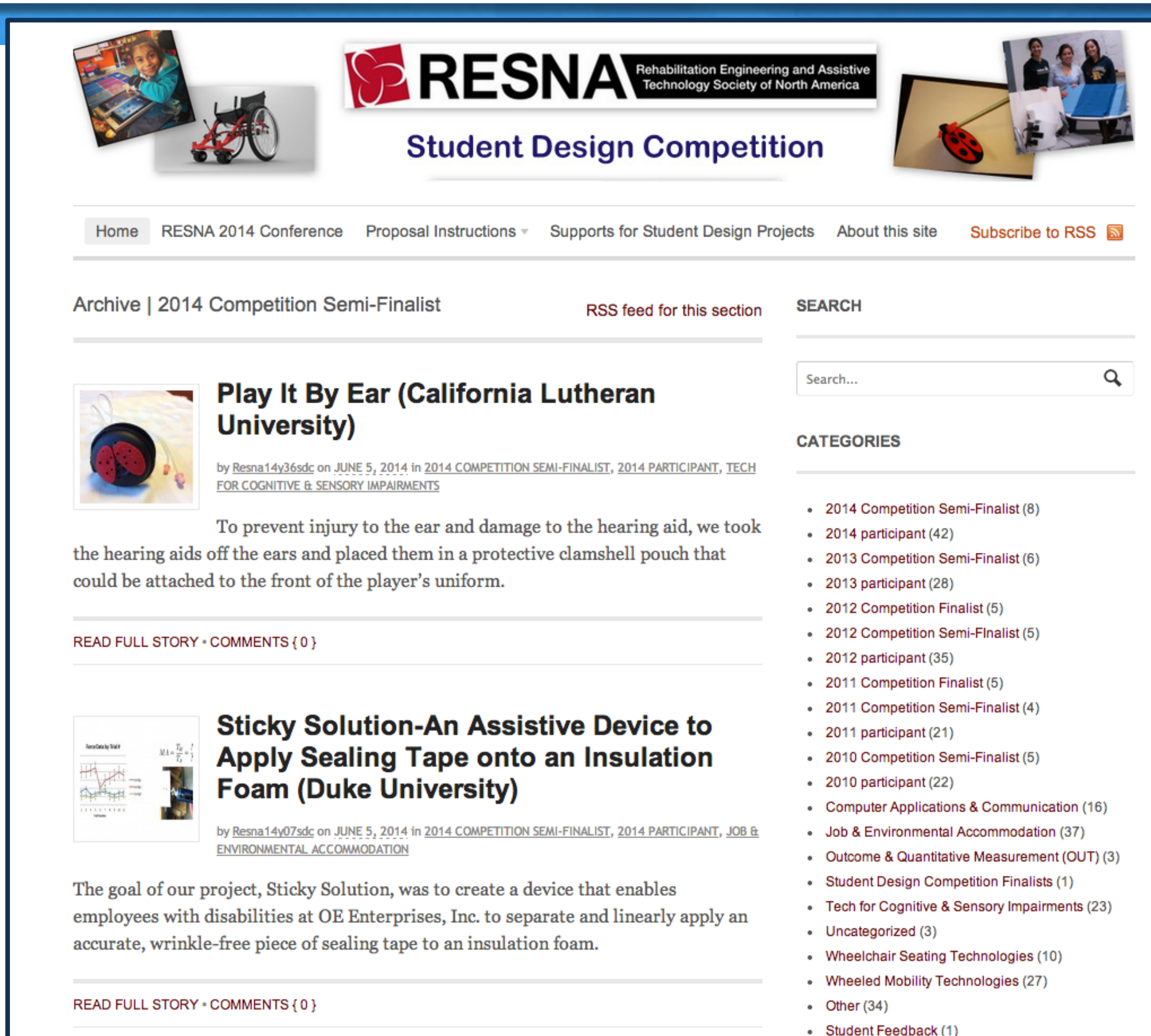
Student design teams

- Learning Factory
- Hack-a-Thon

RESNA SDC

- Prototypes
- Feedback to manufacturers
- Presentations, publications

T4) RESNA Student Design Competition



RESNA Rehabilitation Engineering and Assistive Technology Society of North America

Student Design Competition

Home | RESNA 2014 Conference | Proposal Instructions | Supports for Student Design Projects | About this site | Subscribe to RSS

Archive | 2014 Competition Semi-Finalist

RSS feed for this section

Play It By Ear (California Lutheran University)

by Resna14y36sdc on JUNE 5, 2014 in 2014 COMPETITION SEMI-FINALIST, 2014 PARTICIPANT, TECH FOR COGNITIVE & SENSORY IMPAIRMENTS

To prevent injury to the ear and damage to the hearing aid, we took the hearing aids off the ears and placed them in a protective clamshell pouch that could be attached to the front of the player's uniform.

READ FULL STORY • COMMENTS { 0 }

Sticky Solution-An Assistive Device to Apply Sealing Tape onto an Insulation Foam (Duke University)

by Resna14y07sdc on JUNE 5, 2014 in 2014 COMPETITION SEMI-FINALIST, 2014 PARTICIPANT, JOB & ENVIRONMENTAL ACCOMMODATION

The goal of our project, Sticky Solution, was to create a device that enables employees with disabilities at OE Enterprises, Inc. to separate and linearly apply an accurate, wrinkle-free piece of sealing tape to an insulation foam.

READ FULL STORY • COMMENTS { 0 }

SEARCH

Search...

CATEGORIES

- 2014 Competition Semi-Finalist (8)
- 2014 participant (42)
- 2013 Competition Semi-Finalist (6)
- 2013 participant (28)
- 2012 Competition Finalist (5)
- 2012 Competition Semi-FInalist (5)
- 2012 participant (35)
- 2011 Competition Finalist (5)
- 2011 Competition Semi-Finalist (4)
- 2011 participant (21)
- 2010 Competition Semi-Finalist (5)
- 2010 participant (22)
- Computer Applications & Communication (16)
- Job & Environmental Accommodation (37)
- Outcome & Quantitative Measurement (OUT) (3)
- Student Design Competition Finalists (1)
- Tech for Cognitive & Sensory Impairments (23)
- Uncategorized (3)
- Wheelchair Seating Technologies (10)
- Wheeled Mobility Technologies (27)
- Other (34)
- Student Feedback (1)

RERC on AAC

T5) Doctoral Student Research Think Tank (Summer, 2017)

Dissemination

ATiA 2016

rerc-aac.org


Rehabilitation Engineering Research Center
on Augmentative and Alternative Communication
RERC on AAC
Home
People
Research
Development
Training
Dissemination
Maximizing the literacy skills of individuals who require AAC (webcast)
Search
Search...
Sign up for our eBlast (sent quarterly)
Email address:
Your email address
SIGN UP
Calendar

Outcomes of the RERC on AAC

- 7 high quality research & development projects
  - Increase technical & scientific knowledge in AAC
- More than 10 new innovative AAC technologies / products
  - Designed & tested in our 5 engineering labs
  - Evaluated with individuals with CCN
    - Useable and accessible by people with diverse needs & skills
  - Transferred successfully to the marketplace (in conjunction with Center on KT4TT)

Targeted outcomes of the RERC on AAC

- State of the art multidisciplinary training in AAC
  - More than 150 rehab engineering & science students
- Comprehensive dissemination plan to improve services & results

Funding source

NATIONAL INSTITUTE ON DISABILITY, INDEPENDENT LIVING, AND REHABILITATION RESEARCH

NIDILRR

- Grant #H133E140026
- Janice Light, PI
- October, 2014 – September 2019
- https://rerc-aac.psu.edu/

ATIA business

- **CEUs – Session Code: AAC-37**
  - More info at: www.atia.org/CEU2016
  - For ACVREP, AOTA and ASHA CEUs, hand in completed Attendance Forms to REGISTRATION DESK at the end of the conference. Please note there is a $15 fee for AOTA CEUs.
  - For general CEUs, apply online with The AAC Institute: www.aacinstitute.org.

- **Session Evaluation: URL (to be provided by ATIA Education)**
  - Please help us improve the quality of our conference by completing your session evaluation form.

- **Handouts**
  - Handouts are available at: www.atia.org/orlandohandouts
  - Handout link remains live for 3 months after the conference ends.