

Tools for Supporting Individuals with Autism and other Cognitive Disabilities

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Background

- Assistant Professor starting Autumn 2008
- Received Ph.D. in Computer Science from Georgia Tech working under Gregory Abowd in August 2008
- Assistive Tech related research
 - Abaris: A tool for assisting therapists of children with autism
 - Baby Steps: Helping parents identify early warning signs of disabilities
 - FETCH: A system for locating lost objects for the visually impaired

Outline

- Overview of Cognitive Disabilities
- Detailed explanation of Autism
- Description of Autism-related Technologies
 - From Kientz *et al.* IEEE Pervasive '07 paper
 - Abaris, CareLog, Recognizing Autistic Behaviors
- Overview of Other Autism Technologies
- Overview of Other AT for Cognitive Disabilities
- Discussion of acceptance of AT for Cognitive Disabilities
 - From Dawe CHI '06 paper
- Download slides at:
 - <http://www.juliekientz.com/talks/autism-lecture.ppt>

Definition of Cognitive Disability

- Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) definition of a person with cognitive disabilities
 - One who is “significantly limited in at least two of the following areas: self-care, communication, home living, social/interpersonal skills, self-direction, use of community resources, functional academic skills, work, leisure, health and safety”

Examples of Cognitive Disabilities

- More Severe
 - Autism
 - Down Syndrome
 - Traumatic brain injury (TBI)
 - Dementia
 - Amnesia
- Less Severe
 - Attention deficit disorder (ADD)
 - Dyslexia (difficulty reading)
 - Dyscalculia (difficulty with math)
 - General Learning Disabilities

Functional Deficits

- Memory
- Problem-solving
- Attention
- Reading, linguistic, and verbal comprehension
- Math comprehension
- Visual comprehension

Types of AT for Cognitive Disabilities

- Cognitive Prosthetic
 - Enhancing cognition
- Rehabilitative
 - Help to improve cognitive functioning
- Preventative
 - Help to prevent cognitive functioning
- Assisting Caregiver
 - Help make caregiver's job easier or more effective
 - Often necessary for lower functioning individuals

Areas where AT can help (Dawe, 2006)

- Communication
- Writing
- Prompting/Scheduling
- Reading
- Educational Software
- Alternative Input
- Math
- Remote Communication
- Memory Aids

What is Autism?

- A developmental disability first appearing in young children but lasts a lifetime
- Difficulties in three areas:
 - Verbal and non-verbal communication
 - Social interactions
 - Leisure or play activities
- A spectrum disorder
 - “If you’ve seen one child with autism, you’ve seen one child with autism.”



What Causes Autism?

- Genetic predisposition + some environmental trigger
- Genetics:
 - Autism often runs in families
 - Ratio of boys to girls: 4:1
 - 90% chance of identical twins both having it
- Environmental trigger unknown
 - Some guesses:
 - “Refrigerator mothers”
 - Mercury preservative found in vaccines (Thermosil)
 - Television
 - Rainy days
 - Food allergies
 - Bad nutrition

How is Autism Treated?

- No cure – only can treat symptoms
- Therapy
 - Speech therapy
 - Occupational therapy
 - Applied Behavior Analysis (ABA)
- Communication Tools
 - Picture Exchange Communication System
 - Rapid Prompting Method
- Diet
 - Gluten-free, Casein-free
- Pharmacological
 - Aderoll, Ritalin
- Miscellaneous
 - Music Therapy
 - Swimming with dolphins

How can technology help?

- Ease the burden of data collection
 - Automate some of the collection of data
 - Provide easier ways of accessing relevant data
 - Facilitate in the discussions
 - Help improve the reliability of data collection
 - Provide data that could not be observed otherwise



- A tool to support discrete trial therapy, a popular form of intervention in homes and schools
- Support the collaborative, data-based decision-making process of therapy teams
 - Indexing continuous video to support access during discussions

Kientz *et al.* Ubicomp 2005; Kientz *et al.* CSCW 2006; Kientz thesis

Understanding Autism Therapists

- Discrete Trial Training Therapy
 - A popular therapy for children with autism
 - Teaches basic academic and life skills
 - *e.g.*, handwriting, brushing teeth
- Collaborative Decision-Making
 - One-on-one sessions between student and therapist
 - Regular meetings of therapists



Abaris: Data Capture

Leverages basic therapy protocol to minimize intrusion

Speech detection to timestamp beginning of trial

Record handwriting using Anoto digital pen to collect grades and timestamp end of trial



DISCRETE TRIAL SESSION DATA

Student: John Smith
Teacher: Julie
Date: Saturday, July 07, 2007
Session ID: 123

Matching					Numbers					Singing				
Stimulus	+	-	P	EC	Stimulus	+	-	P	EC	Stimulus	+	-	P	EC
cars	✓				1	✓				hugs	✓			
	✓				2	✓								
crayons		✓				✓								
	✓				4	✓								
	✓					✓								
	✓					✓								
	✓					✓								

Drawing					Sketch					Touching nose				
Stimulus	+	-	P	EC	Stimulus	+	-	P	EC	Stimulus	+	-	P	EC
circle	✓				rolling	✓				finger	✓			
	✓					✓								
box		✓				✓								
	✓				subtraction	✓								
face		✓				✓								
	✓					✓								

Saying "hi"					Cubing					Handwriting				
Stimulus	+	-	P	EC	Stimulus	+	-	P	EC	Stimulus	+	-	P	EC

Abaris: Data Access

Abaris :: BETA
File Program Maintenance AbarisNet Administration

Program Graph Time-based Gr Review multiple sessions

Receptive Inst

100 %
95 %
90 %
85 %
80 %
75 %
70 %
65 %
60 %
55 %
50 %
45 %
40 %
35 %
30 %
25 %
20 %
15 %
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0 %

is (C10)	0	0	55.6 %
is (C10)	I	I	57.1 %
School (sch)	I	M	83.3 %
compi	M	M	37.5 %
"Sa			
Scho			
			64.3 %

Abaris :: BETA
File Program Maintenance AbarisNet Administration

Program Graph Time-based Gr

Receptive Instructions (C10)

Graph preview

Zoom: T4 sessions

Program management

- Receptive Instructions (C10)
- Recat Categories (C10)
- Mastered and On Hold Targets
- Writing Skills (C4)
- in a book (C4)
- short words
- Mastered and On Hold Targets
- Receptive Categories (C10) R
- Receptive Categories (C10) E
- Mastered and On Hold Targets
- Labeling (C10)
- Vocabulary - Words (C15, C4)
- Vocabulary - Objects (C15, C4)
- Vocabulary - Pictures (C15, C4)
- Vocabulary - Pictures (C15, C4)
- Body Parts (C17) R
- Body Parts (C17) E
- Sentences (C19)

Session selection

- View selected sessions
- View selected notes

02/11/2005

02/12/2005

02/20/2005

Therapist: Julie

Location: Basement

Date: 02/21/2005

Time: 02:41:51 PM

Save

Close

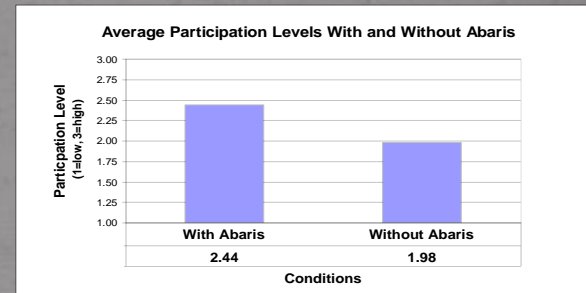
Demo of Abaris

Abaris: Study

- 4 month real use deployment study
 - Case Study: Therapy team for one child
 - 52 therapy sessions (50+ hours of video)
 - 6 team meetings
- Data collected
 - Video coding and analysis of team decisions during sampled meetings
 - Meetings without Abaris: 39 decision points across 3 meetings
 - Meetings with Abaris: 42 decision points across 3 meetings
 - Interviews with team members
 - Software logging of Abaris

Findings

- Increased use of reliable artifacts
 - Videos
 - Graphs
 - Data sheets
- Increased participation among team members



Abaris for Schools

Working with University of Washington's EEU



Created new version of Abaris for a school setting

- Larger teams of teachers working with multiple students
- Similar therapy format to home-based team
- No practice of regularly graphing and reviewing data
- Graph automation and embedded review resulted in decreased treatment time.

Abaris for Schools

Abaris - Print Discrete Trial Form
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Print Discrete Trial Form

Teacher Test Teacher ▾

Student Test Student ▾

	Skill	Category	Last Session %
<input type="checkbox"/>	Matching	Cognitive	100
<input type="checkbox"/>	Sequencing	Cognitive	100
<input type="checkbox"/>	Planning Play with Peers	Social	100
<input type="checkbox"/>	Appropriate Interaction - Commenting	Social	100
<input type="checkbox"/>	Independent Play Following a Sch...	Social	60
<input checked="" type="checkbox"/>	Commenting	Social	50
<input type="checkbox"/>	Functional Language - Requesting	Communication	50
<input type="checkbox"/>	Test Skill	Cognitive	50
<input type="checkbox"/>	Answering WH questions	Communication	42
<input type="checkbox"/>	Independent Play	Cognitive	40
<input checked="" type="checkbox"/>	Expressive Object Identification	Cognitive	30
<input type="checkbox"/>	Peer Imitation	Social	25
<input type="checkbox"/>	Emotion Identification	Social	20
<input type="checkbox"/>	Categorizing	Cognitive	20
<input type="checkbox"/>	Facilitating Eye Contact	Social	20
<input type="checkbox"/>	Imitation - Motor	Cognitive	0
<input type="checkbox"/>	Observational Learning	Cognitive	0
<input type="checkbox"/>	Directing Others' Behavior/Manding	Communication	-
<input type="checkbox"/>	Appropriate Action on Toys	Social	-
<input type="checkbox"/>	Receptive People Identification	Cognitive	-
<input checked="" type="checkbox"/>	Receptive Object Identification	Cognitive	-
<input type="checkbox"/>	Imitation - Object	Cognitive	-
<input type="checkbox"/>	Following Directions	Communication	-

10/15/2006

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80					
60					
40					
20					
0					
	15	15	15	16	16
	Oct	Oct	Oct	Oct	Oct
	2006	2006	2006	2006	2006

Preview Forms

Instructions: Place checks next to skills you wish to appear on the form. Skills from last session are already checked.
 After skills are selected, press "Preview Form" to see what form will look like. If satisfied, close preview window and choose "Generate Forms".
 From the window that pops up, press "Print". Once the form is printed, close popup window and press "Done" to finish.

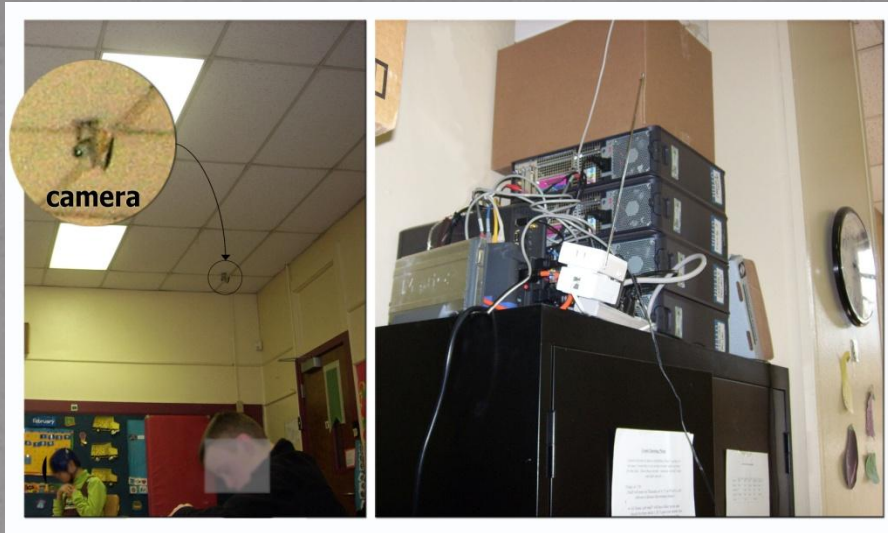
Print Form(s)
Done



- Collecting rich behavioral data in the unstructured natural environment
- Retroactively saving important video
 - Conscious selection of relevant video episodes

Hayes *et al.* CHI 2005; Hayes 2007 (thesis); Hayes *et al.* CHI 2008

After-the fact capture and annotation



CarLog FBA - Incident Review

Student: Doug
 Evaluator: Billy Pugh
 Start Date: 2009-02-07
 Time of Incident: 15:06:14-15:23:14
 Label: 14 min 30 sec

Antecedent: [Edit List](#)

- In chair
- depressed noise
- interaction
- physical prompt
- pulling on another student
- reminded of consequences
- academic lock
- red line
- activity
- smile lock given
- loud to get up
- loud to start

Behavior: Hitting

Consequence: [Edit List](#)

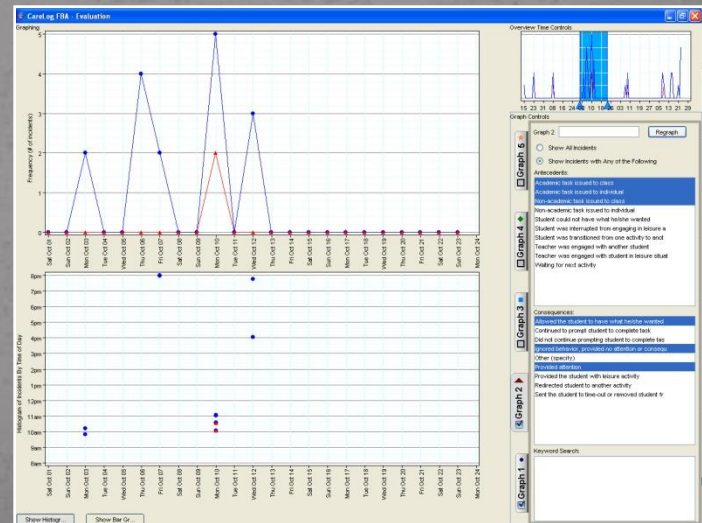
- adult moves away
- change activity
- continues to give SD
- increased noise
- given lock
- ignore
- materials removed
- physical assist
- physical restraint
- quiet room
- redirect
- retractor removed

Comments:

Reaction: Continues; lays down to escape instead

Video: [Four camera views of a classroom]

Cancel Save Changes



CareLog Results

- Studied CareLog in a special needs classroom for several months
- Findings:
 - Significant reduction in missed incidents vs. pen and paper
 - A socially acceptable solution to video recording in the schools
 - Teachers assumed more responsibility for reflecting on causes of behavior

Recognizing Autistic Behaviors

- Machine learning techniques in conjunction with unobtrusive wireless sensors can provide an automatic activity monitor to report daily behaviors of persons with cognitive disabilities

Westeyn, *et al.* ISWC 2005

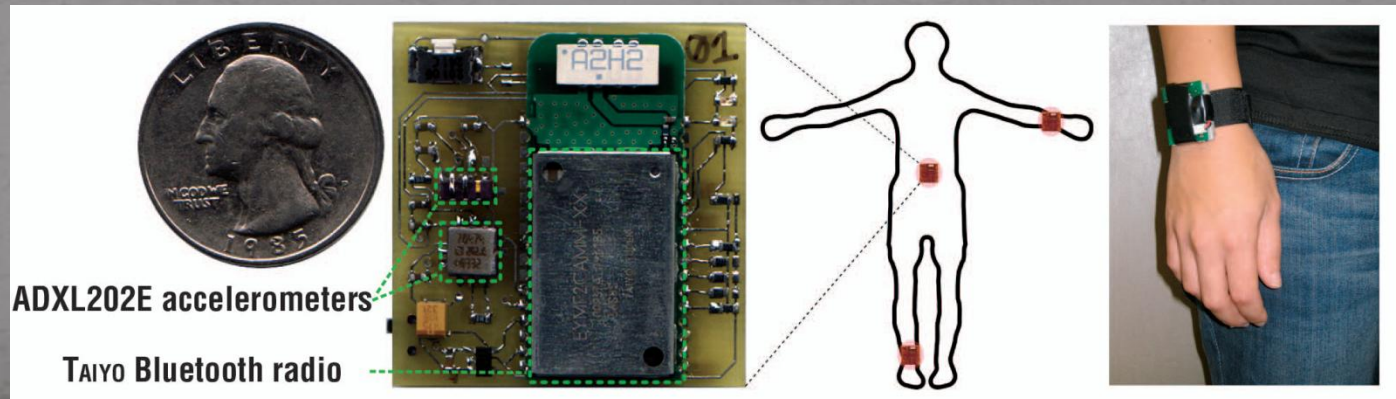


Motivation

- Autism is a developmental disorder affecting both a child's ability to communicate and socially develop
- Signs of nervousness, discomfort, and pain are correlated to self-stimulatory behavior and obsessive-compulsive behavior

Approach

- Use wearable sensors to determine when self-stimulatory behaviors occur
 - Communicate findings to caregiver
 - Can correlate self-stimming behaviors with different needs
- Drawbacks
 - Children may not be comfortable wearing sensors
 - Battery life



Other Technologies for Autism

- Virtual peer for storytelling
 - Tartaro, ASSETS '06



- Emotion prosthetic for recognizing facial expressions
 - Kaliouby & Robinson, Universal Access in the Information Soc '05



Other Technologies for Autism

- Mobile picture schedules for children with autism
 - Hayes et al., UC Irvine



- Biometric Sensors for Autism
 - LifeShirt
 - Goodwin, et al., Groden Center
 - Wearable GSR
 - MIT Media Lab



Other Technologies for Autism

- Touch table games to teach turn-taking skills
 - Piper, et al. CSCW '06
 - Gal et al., Intetain '05

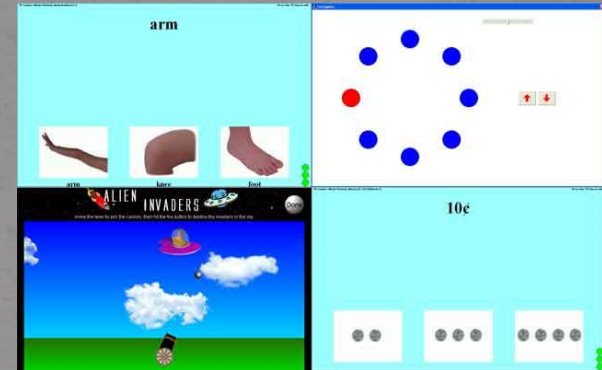


- Virtual Worlds for Individuals with Autism
 - Second Life



Other Technologies for Autism

- Discrete Trial Trainer
 - <http://www.dttrainer.com>



- Virtual reality as training for dealing with difficult events or dangerous situations
 - Strickland, D. Virtual reality in Neuro-Psychology. 1997.



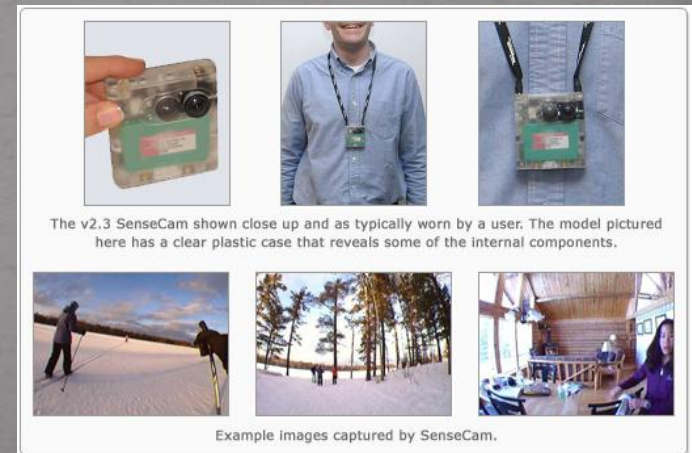
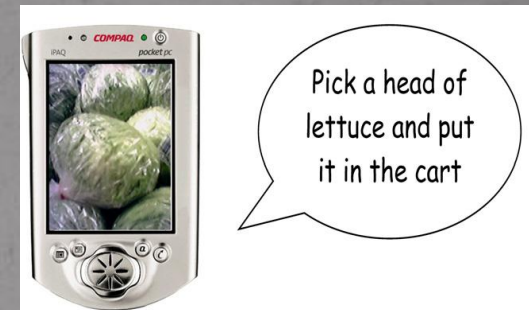
Other Technologies for Autism

- Augmentative Communication Devices
 - GoTalk
 - <http://www.thespeciallife.com/communication-device.html>
 - Dynavox
 - <http://www.dynavoxtech.com>



Technologies for Cognitive Disabilities

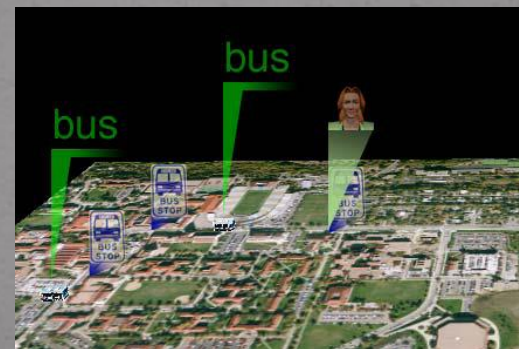
- Memory Aided Prompting System (MAPS)
 - A handheld prompting system
 - UC Boulder
- Memory Book
 - Reminding of medication and appointments
 - Richards et al., 1990
- SenseCam
 - Memory Aid for people with dementia
 - Microsoft Research Cambridge



Example images captured by SenseCam.

Technologies for Cognitive Disabilities

- Project ACCESS
 - Indoor wayfinding
 - University of Washington
 - Liu, et al. ASSETS 2006
- Orienting Tool
 - Helps amnesic individuals navigate
 - Wu, et al., 2007
- Mobility for All
 - Public transit guide
 - UC Boulder



Acceptance of AT for Cognitive Disabilities

- Melissa Dawe at UC Boulder studied families using assistive technology (Dawe, CHI '06)
 - 35% of technologies are purchased but not used
- Implications for AT for Cognitive Disabilities
 - Portability
 - Simple to use, yet configurable to needs
 - Increases social interaction
 - More appropriate social behavior
- Expense is also a concern
 - Limited population means no mass production

Contact Me

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- Download these slides at:
 - <http://www.juliekientz.com/talks/autism-lecture.ppt>