Behavior Imaging: A technology approach to support behavioral science and developmental disabilities

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Who Am I?

Professor, School of Interactive Computing, Georgia Tech

- Applications research in “ubiquitous computing”
- Founder & Director of Aware Home Research Initiative
- Associate Director of Health Systems Institute

Father of three children, two with autism
Punchline – Behavioral Imaging

Imaging technologies have impacted medical science

- Orthopedics and dentistry  X-RAY, ultrasound
- Cardiology  Echocardiogram
- Neurology  MRI / PET / CT

What about behavioral sciences that study developmental/cognitive phenomena

- What is behavioral imaging and impact on quantitative science of behavior
- Behaviors as part of a medical record
Agenda

Personal motivation

Video capture and indexing of interactions
  - support reflection and analysis of children with autism
  - Leverage human in the scene
  - 2 case studies: Abaris and CareLog

Early detection of developmental delay
  Persuasive and automated approaches to support communication and screening/diagnosis

Behavioral Imaging by analogy revisited and a new inspiration for research.
Richard G. Abowd, Jr. was a handsome fellow.

He married Sara, a buddy’s sister.

He was an 8mm film hobbyist.


That Christmas, his faithful projector also died.
The Family Video Archive

Abowd et al., Multimedia Information Retrieval 2003
Patel & Abowd, Ubicomp 2004
One evening, I was converting video from 1998 ...

... I was shocked at what I saw.

Capturing everyday experiences has taken on a whole new meaning for me.

Aidan & Blaise Abowd
Christmas 2002; Australia 2005
Understanding Autism

A developmental disability impacting language, socialization and behavior.

Typically appears in first 3 years of life, often after typical development.

Somewhat subjective means of diagnosis, largely based on observations of child behavior.

A spectrum disorder.
Balancing Priorities

How to be:

- Parent/advocate of special needs children
- Successful researcher wanting to advance career
- Collaborator with relevant experts
- Advisor of students who need to advance as well

My response:

- Scratch your own itches
- Real problems are always research worthy
- Surround yourself with excellence
Three Thrusts

Abaris
- Helps caregivers use real data to assess progress in structured interventions

CareLog
- Capture of data in unstructured activities in the natural environment

Early Detection
- Proactive system for alerting new parents of the symptoms of developmental delay

Common theme: Automated capture
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, CSCW 2006
Abaris: Embedding 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
Abaris: Embedding Access
Abaris in schools

With University of Washington

Abaris for a school setting

- Larger teams of teachers working with multiple students
- Did not have practice of regularly graphing and reviewing data
- Easier reflection lead to decreased instruction time
Three Thrusts

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**CareLog**
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**Early Detection**
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Common theme: Automated capture
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
From research to practice
Three Thrusts

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Common theme: Automated capture
Early Detection

We believe that the earlier autism is detected, the more of an impact therapies can have on the child’s development.

Most diagnoses are made several years after the first warning sign.

Help parents see and report warning signs.

This applies beyond autism.
Technology Goals

Can we better facilitate screening and diagnosis practices?

Current practices heavily rely on:
- parent reporting
- child observation in clinical settings

Enhance evidence gathering of development through:
- Persuasive technologies that motivate/reward collection
- Automated video analysis
- Augmented object interaction
Leverage activities and technologies already present in household

- Baby monitors, baby calendars, still cameras, camcorders

Provide motivations beyond tracking to encourage adoption

- Create valuable keepsakes, simplify responding to developmental questionnaires.

Goal: Increase pediatrician-parent confidence

Formative study details: Kientz et al., CHI 2007
The Baby Steps system

Proactive, interactive
digital baby book

KidCam:
Smart baby monitor
Automated Video Analysis

Retrospective video studies support early detection
- Home movies provide data
- Arduous manual extraction and annotation

This is (my kind of) computer vision expert’s dream!
- Automatic scene extraction
- Automatic scene annotation

Collaboration with Jim Rehg (GT), Grace Baranek (UNC)
Extracting social interactions

Rule-based, turn-taking format; repeatable routine

Important for acquiring prelinguistic communication skill and early intervention
Preliminary results on PeekaBoo

Template

Input video
Child’s Play

Diagnostics based on child observation with objects and people (ADOS)

Collaboration with Thad Starner (GT), Grace Baranek (UNC), Sally Ozonoff (UC Davis MIND)

A child 12 months old offers a prototype block to her parent exhibiting a month 8 developmental milestone.
How do we Observe Play?

Sensors embedded in toys
Detect actions and sounds
- banging, moving, shaking, sliding, rolling ...
Revisit – Behavioral Imaging

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We are on the path

• What I showed today are examples of manual, semi-automated and automated coding of (mostly) visual behavior information

• We are building tools to facilitate sharing across caregiver network

• I am looking for collaborators that see the research potential for understanding developmental phenomena
My latest inspiration

I saw Aidan spontaneously communicate for the first time in 8 years two weeks ago.
Another Holy Grail

Understanding the reasons why academic interventions work.

- Example: Rapid Prompting Method at HALO Institute.
- Autism does not equal mental retardation
- Plenty of anecdotal evidence, no research-based evidence to convince schools
- Cognitive Science, Neuroscience and Imaging

Then train and reproduce the results

- Robotics: a teacher for every student
- Why not start with special needs?
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Questions?

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