Ubiquitous Care: Case studies in human-centered technology for health and education

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Distinguished Professor, School of Interactive Computing
W. George Professor and Director, Health Systems Institute
Who Am I?

Professor, School of Interactive Computing, Georgia Tech

- Human-centered computing based in “living laboratories”
  - Created Classroom 2000
  - Founder of the Aware Home

Director of Health Systems Institute
But really...who AM I?

10th of 12 children from Detroit

1967

1980
A mathematician meets magic

Past education

- B.S. in Mathematics (Notre Dame 1986)
- M.Sc. and D.Phil. in Computation (Oxford 1987, 1991)
- Postdocs at University of York (90-92), Carnegie Mellon University (92-94)

Then I arrived at Georgia Tech, and something happened to me...
Formalizing the Past vs. Inventing the Future
That was then, this is now...

Father of three children, two with autism
1998: a VERY important year for me

• Began the Aware Home effort
  – Aging in place, chronic disease management, ubicomp for real
• My father died...
• My oldest son changed before my very eyes...

“We are all faced with a series of great opportunities brilliantly disguised as impossible situations.”
Charles Swindoll
My father

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.
Hey, Dad, look at this!
Technology and Autism

One evening, I was converting video from 1998, and I was shocked at what I saw.

Aidan, 18 months

Aidan, 26 months
Are you at the right lecture?

That’s all very touching, Gregory, but what is your point?

Make IT matter!

Encourage passion, creativity and technical competence when you teach/research.
More specifically

Explicit message:
The challenges presented by autism present a great opportunity for many different kinds of computing research.

Implicit message:
Over time, collaborators will come.
This is not unique to autism. Choose your own substitute.

“It is the responsibility of leadership to provide opportunity, and the responsibility of individuals to contribute.” (William Pollard)

- Gregory’s corollary: Good leaders are good individuals.
Opportunities

Examples of computing research stemming from autism and technology exploration

- Early detection of developmental delay
- Data collection for evidence-based interventions
- Designing interventions for the individual
- Understanding the autism phenotype
Autism spectrum disorders

A neurological disorder characterized by:
- Deficits in reciprocal social interactions
- Deficits in communication
- Restricted repetitive behaviors

It is highly individualized, with genetic and environmental components.

There is **A LOT** we do not understand.
Challenges/Opportunities

Many stakeholders

- The individual, the family and friends, teachers, therapists, clinicians, and researchers

Many stages in the continuum of care

- Screening, diagnosis, treatment, monitoring, transition to adulthood

How can technology help?

I have a valuable perspective as parent, advocate, interdisciplinary research colleague & advisor.
A continuum of care

Screening

Interdisciplinary Evaluation and Diagnosis

Develop comprehensive treatment plan based on specific needs of the child

Intervention:
• Behavior
• Education
• Language
• Social skill acquisition
• Medical Management
• Community integration
• Child and family education & support

Continuity of Care

Continual Follow-Up

Transition to adulthood
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 signs.

Diagnosis based on parent report and clinical observation

This applies beyond autism.
Technologies for Early Detection

- Proactive baby calendar + smart baby monitor
  improves parent observation

- Activity recognition + simplified screening
  improves direct clinical behavior observation

CDC

Learn the Signs. Act Early.

RAPID-A Screener

SMILING & SAYING "HELLO"

BALL PLAY

Health Systems Institute
A Georgia Tech / Emory Initiative

GVU Center
Georgia Tech
College of Computing
Video mining of social interactions

Social interactions include:

- Repetitions of interactions
- Turn-taking between partners

Ping Wang with Jim Rehg (ICCV’09)

A Peek-a-boo Game
Unstructured video: Home movies
Social Games are *Quasi-Periodic*

Repetitions with Variations

Variations:
- rhythm and poses
Social Games are \textit{Quasi-Periodic}

Random Insertion or Deletion of Actions

Turn the cloth upside down
Detect quasi-periodic events without the knowledge of how the quasi-periodicity occurs

- Periodic motion analysis is not applicable

Detect games without knowing what they are and how they are played

- Supervised methods are not practical since it is difficult to collect representative data

The approach

- No need to pre-define activities
- No need to learn vocabulary of actions
- Automatically parse the stages of a game
2: clapping right hands
Design of the RAPID-ABC

1) Behavioral assessment of infants 15 to 27 months
   - Attention and Affect
   - Back-and-forth interaction
   - Communication (e.g., pointing)

2) Minimize pediatrician’s work load:
   - Assessment can be completed and scored in < 5 minutes
   - One-page protocol
   - Streamline training for non-experts
   - Assessment instrument is easily obtained
Development of a one page protocol
Opportunities with RapidABC

• Automated scoring and cross-clinic aggregation to support surveillance

• Quantitative assessment of the interactional synchrony between child and adult
  – Taking a “social reflex” at the doctor’s office.
Goal: Transforming Science?

Imaging technologies impact medical science

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

Behavioral sciences study developmental & cognitive phenomena

- What is Behavior Imaging and how can it impact the quantitative science of behavior?
- What does it mean to have visually-observable behaviors as part of a medical record?
A continuum of care

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Continuity of Care
Continual Follow-Up

Transition to adulthood
Supporting evidence-based interventions

Data is important, but it is often hard to collect, aggregate, analyze, and, most importantly, share.
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
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
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
Translation to practice

Supported in part by NICHD SBIR Phase 1 and 2 grants
CRAFT: Can parents collect data?

- Collaboration with Marcus Autism Center
  - Nathan Call, Director of Severe Behavior Program
  - Rosa Arriaga, Yi Han, Nazneen
  - HSI-CHOA seed grant
- What would convince MAC to use CareLog/BI Capture?
  - Economic incentive to reduce travel
  - Has to be a good way to catch the behavior episodes and details
  - How many cameras are needed? How long to deploy?
  - Would insurance pay for this?
A continuum of care (CHOA)

Screening
Interdisciplinary Evaluation and Diagnosis

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But for the individual

Continuity of Care
Continual Follow-Up

Transition to adulthood
Refl-ex: Teaching social skills

With Juane Heflin and Jackie Isbell, GSU

- Social stories: A way to teach an individual appropriate social actions.
- Refl-ex: a more interactive way to teach why certain behaviors are and are not appropriate.
A continuum of care

What about basic understanding of the autism experience?

Intervention:
- Behavior
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Continuity of Care

Transition to adulthood

Continual Follow-Up
Understanding Autism

Research and individual accounts provide interesting insights into this complex human condition.
VITA: Visual Thinking in Autism

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THINKING IN PICTURES—WHAT MIGHT IT MEAN?

 Individuals with autism

<table>
<thead>
<tr>
<th>Content</th>
<th>Encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pictorial</td>
<td>Verbal</td>
</tr>
<tr>
<td>Appearance—“what” and “where”</td>
<td>Arbitrary—driven by inferential needs</td>
</tr>
<tr>
<td>Analogical—structural correspondence</td>
<td>Propositional—no correspondence</td>
</tr>
</tbody>
</table>

Typically developing individuals
Behavioral studies to design tools for assessment—“Cognitive phenotyping”
Reflection

• This has been a very successful agenda, and promises to remain so.
  – 2 PhD students at top universities
    • 1 former student has moved into this area
  – 2 more to graduate this year (co-advised)
  – At least 4 more in the pipeline
  – Atlanta Autism Consortium and the 10-year commitment by CHOA/Marcus Autism Center
  – Commercialization
Team Science?

• Probably not, but it is the best example in my career of involving many different research minds.
  – Connecting to autism researchers vital to success, but that’s not surprising
    • Local expertise: Rosa Arriaga (Ph.D. in Dev. Psych) and Agata Rozga (GSU-GT, Dev. Psych)
  – What is surprising (or at least very satisfying) is the growing number of other computing researchers getting involved.
    • Jim Rehg (computer vision), Ashok Goel (cognitive science), Andrea Thomaz (robotics), Thad Starner (machine learning)
    • There are plenty more out there!
Revisiting the message

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Acknowledgements

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Other colleagues

Opal Ousley (Emory), Juane Heflin (Georgia State)

Support

Cure Autism Now/Autism Speaks, OAR, NSF, NICHD
Questions?

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