And now, the *discussion topic* we've all been waiting for...
The Papers

Predictors of assistive technology abandonment

- **Topic:** Survey of 200+ people who have used / are using assistive technology
- **Purpose:** Determine how technology users decide to accept/reject assistive technology

Real-time Feedback for Improving Medication Taking

- **Topic:** 10 month longitudinal study of 12 people who take multiple medications daily
- **Purpose:** Identify the effects of feedback on medication-taking behaviors
The Big Take-Aways (and how we can apply them)

- Importance of considering the users when building (assistive) technology we want them to actually use
  - Project: mobile app to self-report on emotional disorders
  - Project: alerting users when they're drifting off while driving
  - Project: augmented "turn signals" while biking

- Use of statistics for evaluation: proving we're significantly different ("statistically") from the other guys
  - Project: evaluating user confidence during testing
Predictors for Abandonment
The Big Question:

Can we predict the abandonment rate of digital assistive technology?
The Bigger Question:

Can we use what we know about assistive technology abandonment to create devices that are more widely accepted?
# Research Design Methodology

## Surveys

### Demographics
- Age
- Sex
- Ethnicity
- Nature of Disability
- Income
- Education
- Employment
- Independence Level

### Device Category
- Kitchen and Other Household
- Leisure and Transportation
- Communication Aids
- Broad Use Devices
- Mobility Aids
- Personal Use Devices

### Questionnaire
- 26 Yes/No and Multiple Choice
- 4 Opened Ended Question
  - Selection
  - Acquisition
  - Device Performance
  - Device Use Over Time
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Sample

Nationwide
18 or older
Capable of responding to questionnaire
Experience with at least one assistive device
Is 227 enough people to draw conclusions on device abandonment patterns for everyone? That number is nothing in comparison with how many people there is in the planet.

-ELENA
The research in the paper is very broad—it looks at old and young users as well as limited to fairly independent users. Could more useful information be gathered from a more focused user study?

-CARLY
Research Design Methodology

Definition

Abandonment

Abandonment
Research Design Methodology

Definition

Abandonment
Research Design Methodology

Procedure

Letters sent out to potential candidates

Candidates were interviewed over phone and in group settings
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Data Analysis

TABLE 1. Factor loadings of device attributes (R values)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Performance</th>
<th>Energy demand</th>
<th>Convenience</th>
<th>Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform better</td>
<td>0.744</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable</td>
<td>0.701</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfortable</td>
<td>0.725</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to use</td>
<td>0.566</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe</td>
<td>0.585</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear well</td>
<td>-0.479</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training required</td>
<td>0.756</td>
<td>0.684</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to assemble</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand energy (self)</td>
<td></td>
<td></td>
<td>0.499</td>
<td></td>
</tr>
<tr>
<td>Easy to store</td>
<td></td>
<td>0.881</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to transport</td>
<td></td>
<td>0.866</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Require aid</td>
<td></td>
<td></td>
<td>0.541</td>
<td></td>
</tr>
<tr>
<td>Demand energy (others)</td>
<td></td>
<td></td>
<td>0.773</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 5. Logistic regression estimates of probability of device abandonment

<table>
<thead>
<tr>
<th>Variables</th>
<th>B (beta)</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical attributes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>0.873*</td>
<td>0.099</td>
</tr>
<tr>
<td>Convenience</td>
<td>0.161</td>
<td>0.094</td>
</tr>
<tr>
<td>Energy demand</td>
<td>-0.021</td>
<td>0.094</td>
</tr>
<tr>
<td>Assistance</td>
<td>-0.135</td>
<td>0.101</td>
</tr>
<tr>
<td>Selection and acquisition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion considered</td>
<td>0.762*</td>
<td>0.306</td>
</tr>
<tr>
<td>Easy to obtain</td>
<td>1.326*</td>
<td>0.418</td>
</tr>
<tr>
<td>Who identified need</td>
<td>0.044</td>
<td>0.231</td>
</tr>
<tr>
<td>Who paid</td>
<td>0.127</td>
<td>0.219</td>
</tr>
<tr>
<td>Who owns</td>
<td>-0.208</td>
<td>0.402</td>
</tr>
<tr>
<td>Alternatives available</td>
<td>-0.033</td>
<td>0.278</td>
</tr>
<tr>
<td>Ongoing use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs/priorities</td>
<td>2.563*</td>
<td>0.208</td>
</tr>
<tr>
<td>Complaints from others</td>
<td>-0.005</td>
<td>0.282</td>
</tr>
<tr>
<td>Intercept</td>
<td>-2.672</td>
<td>0.668</td>
</tr>
</tbody>
</table>

Correctly classified at 84.24%

* p < 0.001.
Results

Mobility Aids tended to be abandonment more often

User’s perceive sense of independence in public settings factors abandonment rate

Abandonment rates lower after the first year and increase after 5 years
Research Design Methodology

Factors

Lack of Consideration of User Opinion
Easy Device Procurement
Poor Device Performance
Change in User’s Needs
The authors discuss increasing training in assistive technologies. Why is this critical when lack of training is not identified as a major reason for device abandonment?

-MICHAEL
It seems a major factor in this was the user's perceived independence. How can designers address this need, or is it something somewhat inherent to the individual?

-THOMAS
Is it possible the results of this study may be skewed in terms of why people abandoned their devices? If users felt that "simple and easy to use" devices were not actually simple, would they be too embarrassed to name this as the primary reason for abandonment?

-SPENCER
I feel like some of the studies covered (ADL et al) may have been more informative divided by male, female, age range, and possibly income or education level. I noticed that the survey presented captures some of these demographic elements. Did ADL and other simply leave this information out or was it just not presented in the paper?

-JAKE
Would it have been useful to explain when devices break? Five years of use could be abandonment simply because there is a newer device, or that one broke.

-JARRET
Medication Feedback
Plato is to Aristotle as Abowd is to...

Gregory Abowd

Anind Dey

Matthew L. Lee
Introducing... dwellSense
Self-Regulation Theory

- "Regulated by the continual exercise of self-influence"

1. Self-Monitor
2. Self-Judge
3. Self-Reinforce
The Researchers' "Research Questions"

1. How does real-time feedback help individuals improve the consistency of their medication-taking behaviors?
2. How does real-time feedback affect self-efficacy for medication taking?
3. How do medication-taking behaviors change when removing real-time feedback after long-term use?
The System

1. Augmented 7-day pillbox with:
   1. 3-axis accelerometer to track when the pillbox is picked up
   2. Spring switches on the doors to track when the doors are opened
   3. Custom circuitry with PICAXE microcontrollers
   4. XBee wireless modem.

2. Ambient Display (10" Samsung Galaxy Tab) displaying:
   1. Status of current day’s AM/PM medications
   2. Missed phone calls
   3. Coffee-making habits
The Pillbox
"The sensor cannot actually detect whether the individual has swallowed the pills. [It is meant] to avoid unintentional non-adherence"

This system greatly contrasts other systems that forced you to do things - i.e. bed that physically pushes you out of it. For systems to be useful for change, users need to want to change.

How would this system have worked differently with intentional non-medication takers?
The Ambient Display
"LATE" imposes a deadline, but the time is user-defined. How does this affect perceptions of self-regulation and keep up independence?
If they wanted to track medication habits, why would they decide to couple medication habits with phone and coffee-making habits?

Does associating a mundane task like taking medications with more cognitively-demanding tasks (like answering the phone) make it more "interesting" to the doer?
"All other features on the tablet were disabled."
Why does this matter for an "ambient display"?
The Study

- 12 Participants aged 52-83 with chronic conditions requiring multiple medications daily
  - All participants initially self-reported that they took their medications consistently daily
- Split into two groups:
  - Control and Feedback
- Split into three phases:
  - Baseline, Display, Follow-Up
The Results
Self-Efficacy

- Baseline: Users rated “Not Confident”, “Somewhat Confident” for 13 situations
- Display: Users asked “With the help of the display, do you feel more confident, less confident, or no difference about taking their medications.”
Adherence:
"how often pills are taken"

- Base-Line: no significant differences between groups
- Display:
  - The feedback group improved in their adherence rate increasing from 94.5% in the baseline phase to 98.4% in the feedback phase
  - The control group remained relatively unchanged, going from 93.7% to 92.1%.
  - The interaction between group and phase was not statistically significant ($F[1,67]=2.33, p=0.131$).
  - Ceiling Effect for feedback group
- Follow-Up: feedback group significantly decreased their medication adherence (from 98.4% to 96.2%, $F[1,41]=5.86, p=0.0201$)
**Promptness**: "whether the pills are taken before user-specified ['late' time]"

- **Base-Line**: no significant differences between groups
- **Display**:
  - Rate of the feedback group significantly improved from 75.1% to 90.8%.
  - Control group stayed relatively unchanged, going from 78.8% to 75.4% ($F[1,67]=11.40, p=0.0012$)
- **Follow-up**:
  - Feedback group significantly decreased promptness (from 90.8% to 83.6%, $F[1,41]=5.8, p=0.0208$)
Variance: "how the time of day that medications were taken varied"

- Base-Line: no significant differences between groups
- Display:
  - Significantly decreased from 15.5 to 5.0 in feedback group
  - Increased for the control group from 13.07 to 30.47, attributed to participants feeling more relaxed about having their medications recorded
  - The interaction effect between group and phase was statistically significant (F[1,66]=17.33, p<0.0001).
- Follow-up:
  - Marginally significant increase in the variance of the time of day medications were taken (from 5.03 to 9.82 hours F[1,41]=3.34, p=0.075)
The users of the pillbox explain that there was such a large urge to validate their actions they would look at the display as soon as they took a pill. At what point would using this system, become being reliant on this system, and could being reliant on a system like this cause problems?

- JARRET
Why do you think performance dropped back down after the display was removed?

What would it take for sustained improvement without reliance on another device? Longer time using the technical aid?
The paper’s research proved that real-time feedback to a user can improve performance in a self-regulating activity. What other daily activities could be improved with this kind of real-time feedback system in place?

- CARLY
What would it take for this to go out to the public? It seems to me that this could be implemented very easily and would be very helpful.

- ZACK
Are there any smart med products like those discussed in the article that are actually performing better than expected and gaining significant market share?

- THOMAS
Dementia is a common problem among older people. Does this device help counteract the "forgetfulness" associated with it?

- THOMAS
Evaluating dwellSense & Related Work (for Abandonment)
Researchers say reminders...

- "can be intrusive or heavy-handed"
- "do not fit well into the self-regulation process used to adopt a new behavior because they do not provide feedback for refining the behavior"

How does this fit into the abandonment model of the first paper?
Researchers say...

"We speculate that if we required the user to walk up to the tablet and request a report to get feedback that they would not have viewed the feedback very often, if at all, particularly because most felt they did not need “help” in taking their medications."

"Participants in our study commonly looked at the screen just to check how they were doing and this made them feel secure"

How does this fit into the abandonment model of the first paper?
The Evolution of dwellSense
dwellSense

Wellness through sensing and reflection.

A system for sensing, rating, and reflecting on how older adults carry out tasks for independence. It combines unobtrusive sensing, heuristic-based activity recognition, and multiple forms of feedback mechanisms based on behavioral theory to empower individuals with greater self awareness of their abilities and empower clinicians and caregivers with early, actionable signs of cognitive or functional decline in older adults.
CMU to research sensors to track elderly
Cognitive, physical abilities measured for older adults
March 4, 2010 10:00 AM

Somewhere in the city today, researchers from the Quality of Life Technology Center will go to the high-rise residence of an older adult living alone and equip such everyday items as a pillbox, telephone, or sofa with wireless, computerized sensors. Their hope is to use those small sensors to track any decline in the resident's cognitive or physical abilities long before either normally would be noticed.
Smart Lifelogging Technology for Episodic Memory Support

Matthew L. Lee (Carnegie Mellon, USA) and Anind K. Dey (Carnegie Mellon, USA)

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Recent episodic memory impairment (EMI) affects over 26 million individuals with Alzheimer’s disease. Smart lifelogging technologies can capture a log of the user’s personal experience using wearable or embedded recording devices and present elements of that log as cues that can support memory recollection for people with EMI. In this chapter, the authors describe their design process for developing and evaluating a smart lifelogging system specifically designed to help people with mild EMI remember their experiences better and reduce the burden on their caregivers. The authors’ design process includes two formative field studies to understand both what lifelogging data is most effective for supporting memory and how to present these data. The authors found that their self-guided approach was more effective at supporting people’s ability to retain a detailed memory of their experiences, to feel more confident about their memory abilities, and to reduce the additional burden placed on the caregiver than a caregiver-guided approach.