
Pervasive Technologies for Health: a Focus on the Human

Kay Connelly
Indiana University

“The groundwork of all happiness is health.”

-- Leigh Hunt

1784-1859, British Poet, Essayist

Pervasive Tech for Health

- Current health infrastructure becoming overloaded
 - Formally terminal diseases are now chronic diseases
 - People are living longer
- People are becoming more proactive about their healthcare
 - Doctor/patient roles changing
- New opportunities for technology to support health-related behaviors

Outline

- Motivation
- Indiana University Projects
 - DIMA
 - Chick Clique
 - ETHOS
- Looking Towards the Future

Design Process

- User-centered
 - Consult experts
 - Verify assumptions with target population
- Iterative design
 - Obtain user feedback, early and often
 - Incorporate into designs

“To safeguard one's health at the cost of too strict a diet is a tiresome illness indeed.”

-- Francois De La Rochefoucauld

1613-1680, French Classical Writer

Hemodialysis Patients



- **Daily Limits:**
 - 1 liter water
 - 1 gram sodium
- **80% cannot adhere to diet**

Hemodialysis Patients



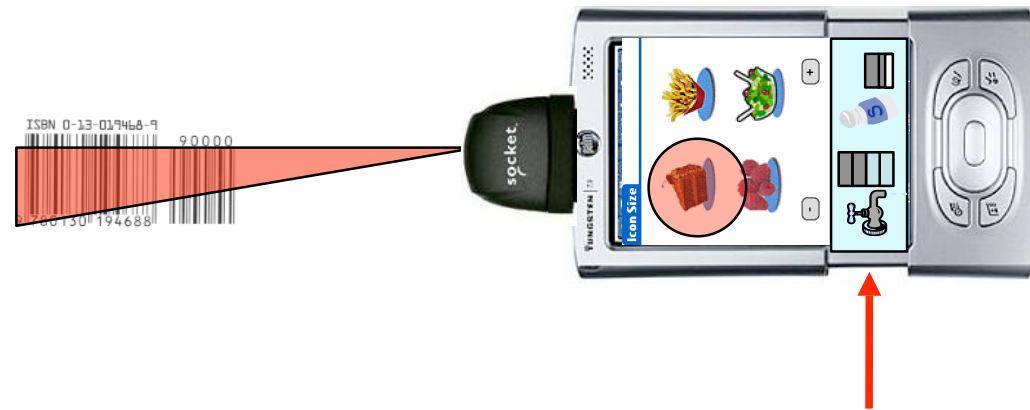
- **1/3 cannot perform conversion calculations**
- **Urban population: low literacy rates**

Hemodialysis Patients



- **Paper diaries have 11% compliance rate**
- **Electronic diaries have up to 94% compliance**

DIMA Approach



Dietary Intake Monitoring Application

- Portable device to track nutrition anywhere
- Bar code scanner for easiest input
- Icons for foods without bar codes
- Real-time feedback

Iterative Design Process

- Study #1: Can they physically use PDAs? *(Interact '05)*



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- Study #3: Voice v.s. scanning *(Chapter in Mobile Health Solutions 2008)*



Iterative Design Process

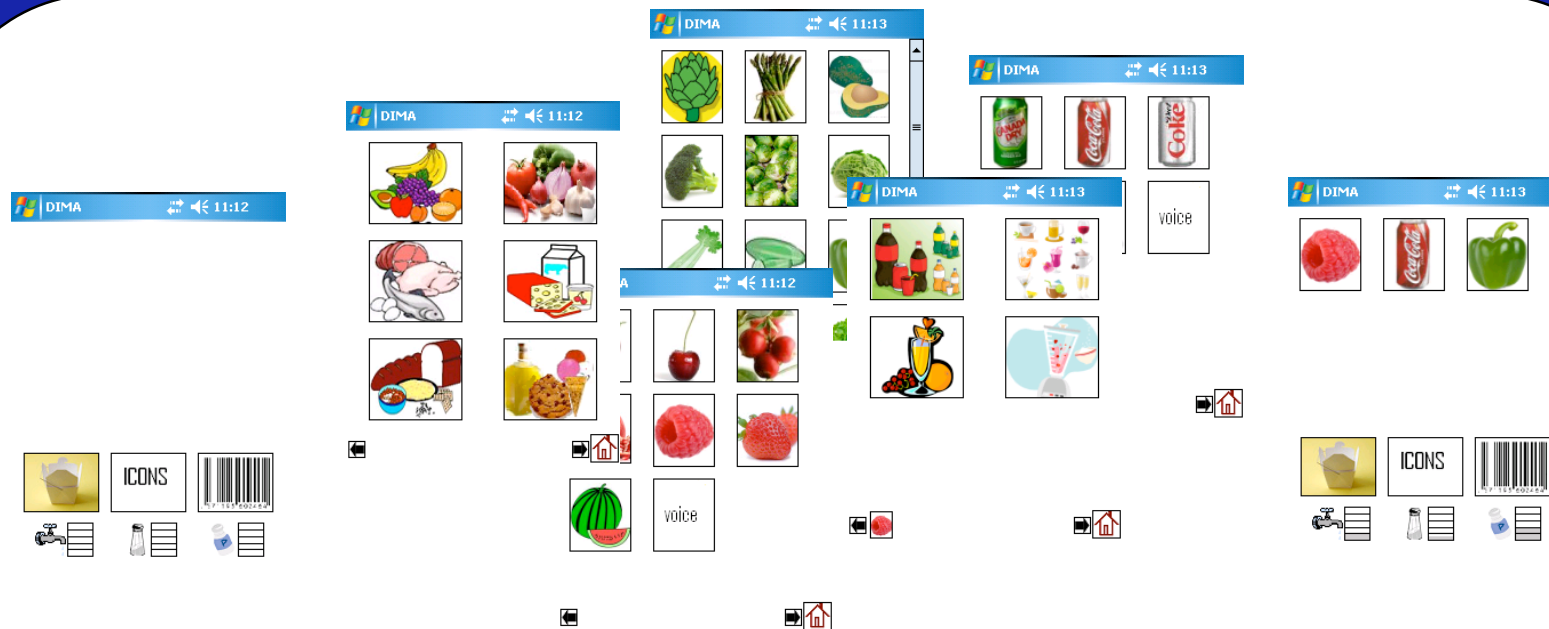
- Study #1: Can they physically use PDAs? (*Interact '05*)
- Study #2: Can they scan barcodes at home? (*PervasiveHealth '06*)
- Study #3: Voice v.s. scanning (*Chapter in Mobile Health 2008*)
- Study #4: Icon interface
 - #4A: Icon choices (*CHI '06*)
 - #4B: Navigation



Emergent Themes

- Integration into daily routines very important
- Showing off to others
 - Technology is a status symbol
- Domain experts didn't always have it right
- Patients lie to their caregivers
 - Need to support that

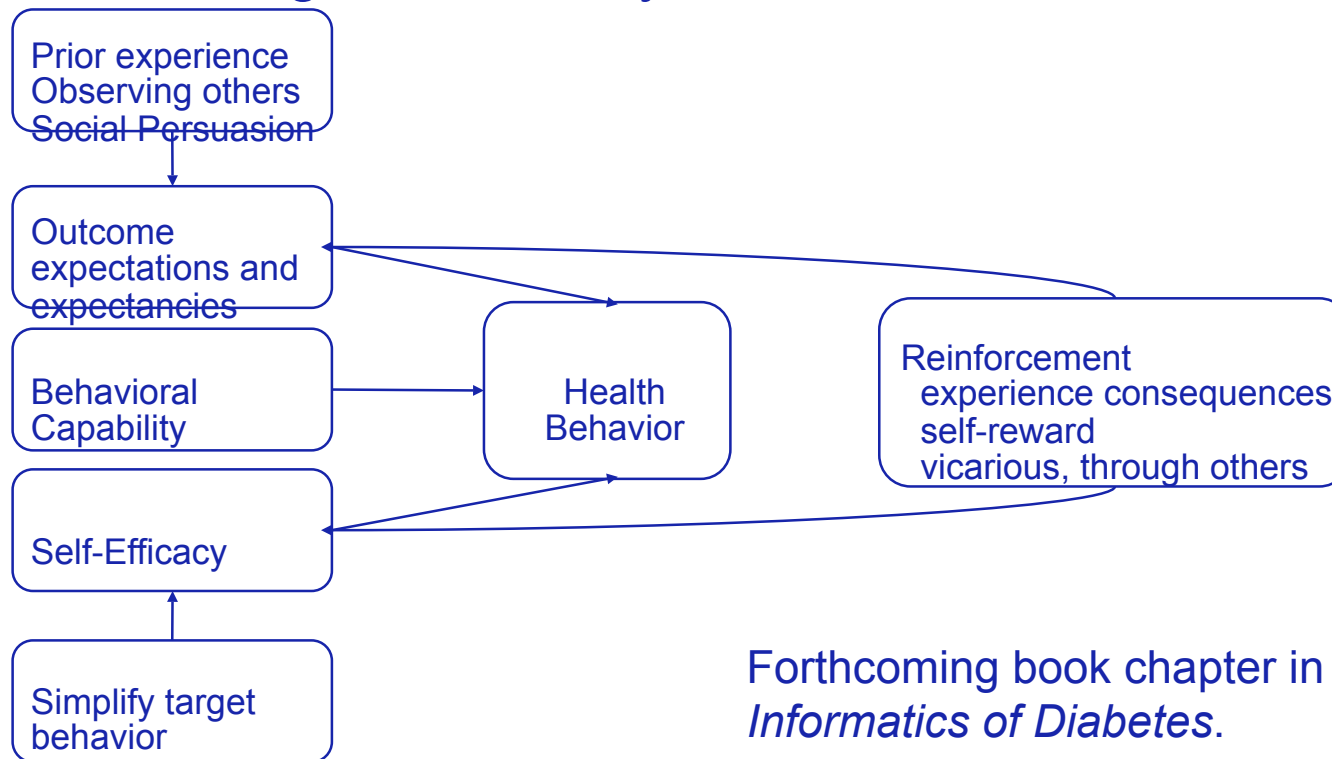
DIMA Prototype



- 6 week pilot study
 - 20 participants using DIMA
 - 20 control participants, tracking physical activity
- Clinical trial if initial results are promising

Behavior Theories

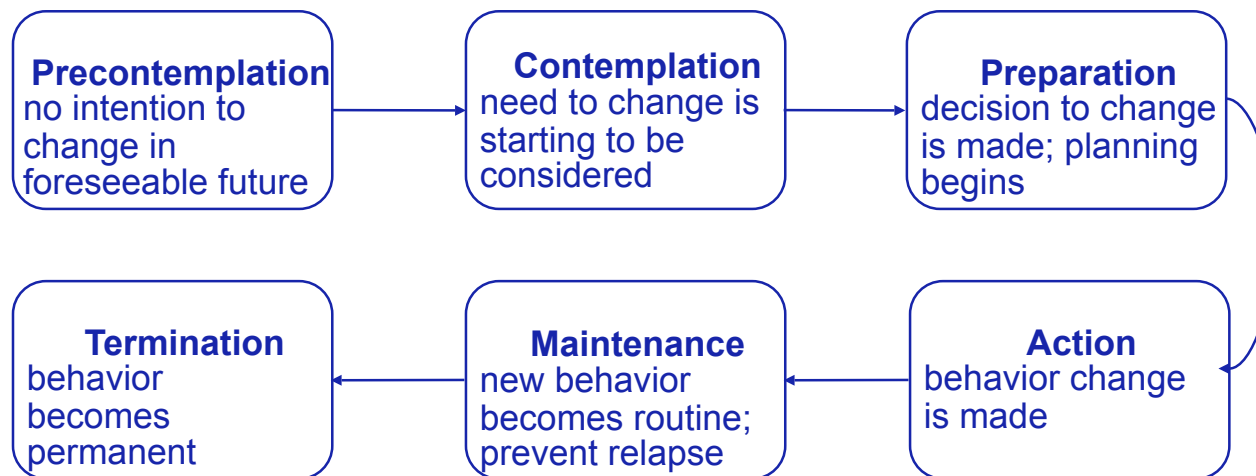
- Ground Designs in existing behavior theories
 - Social Cognitive Theory



Forthcoming book chapter in
Informatics of Diabetes.

Behavior Theories

- Ground Designs in existing behavior theories
 - Transtheoretical Model (Stages of Change)



Forthcoming book chapter in
Informatics of Diabetes.

“We are under exercised as a nation. We look instead of play. We ride instead of walk. Our existence deprives us of the minimum of physical activity essential for healthy living.”

-- John F. Kennedy

Thirty-fifth President of the USA

Teen Obesity



- Overweight adolescents in US have tripled in past 20 years

Teen Obesity



- US Surgeon General says adolescent obesity primarily attributed to
 - Inactivity
 - Poor dietary habits

Teen Obesity



Teenage girls, when compared to boys:

1. Become increasingly inactive during adolescence
2. More likely to use unhealthy weight control methods
3. More receptive to health behavior modification

Chick Clique

Modeling



Social support

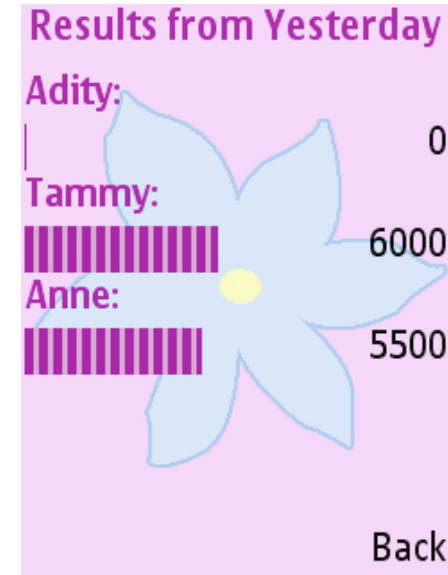
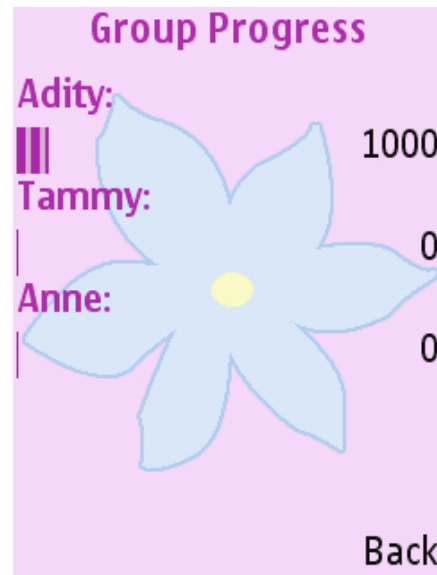


Verbal persuasion

CHI Student Design
Competition winner,
PervasiveHealth '08

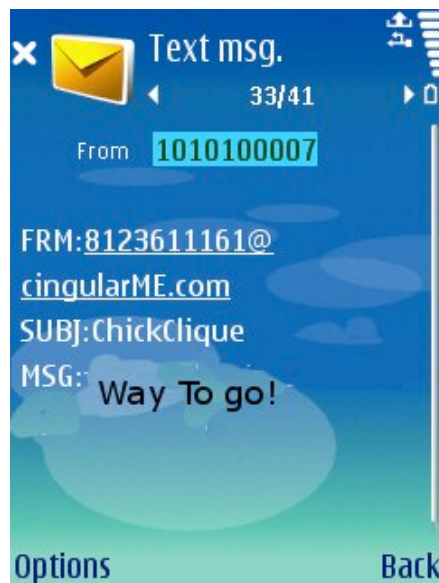
Europe, Oct-Dec, 2008.

Chick Clique: Step and Share



- Girls wear pedometers
- Enter step count periodically throughout day
- Can monitor progress of the entire group

Chick Clique: Texting



- For our user study, we recorded all texts between girls, even if sent outside of Chick Clique

Emergent Themes

- Need scaffolding for text messages
 - Templates
- Modeling is positive, but competition could be perceived negatively
 - Short interventions, or
 - Share progress in game, but no direct comparison
- Reciprocity is necessary when relying on social support
 - Prompt non-participating users to enter step count
- Group composition
 - Small groups of close friends

In-Situ Evaluation

- People's attitudes about technology are often very different before/after experiencing the technology
- Usage often declines over time after "wow" factor has subsided

“Health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity.”

-- World Health Organization

ETHOS

Ethical Technologies in the Homes of Seniors



- In the US, 13% of the population is over 65. By 2030, it will be about 22%.
- Those over 85 are the fastest growing age segment of the population.
- Technology holds great promise for maintaining and improving the health and well-being of the growing older adult population.

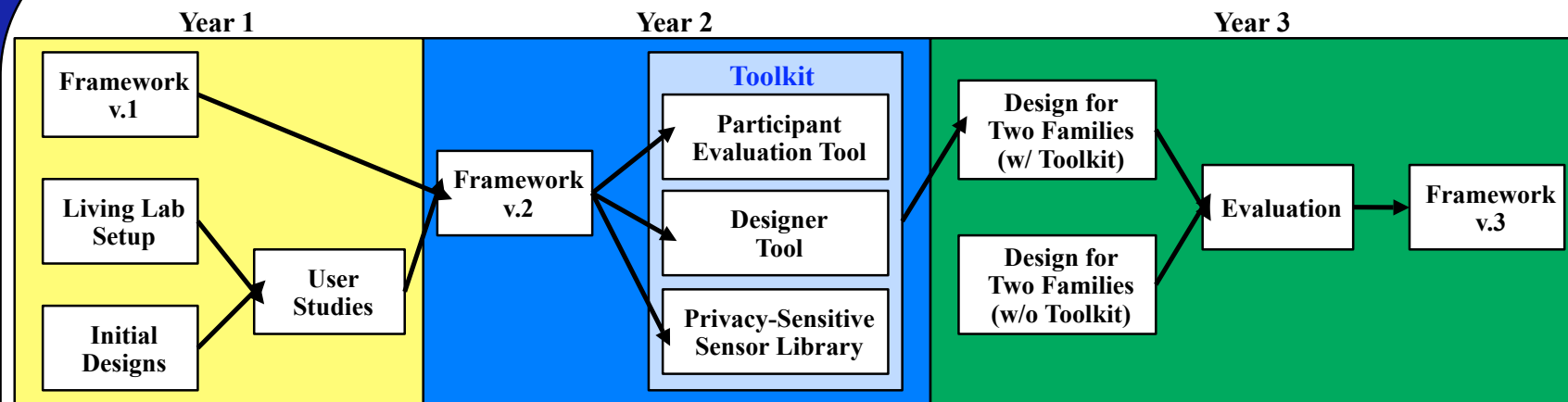
- Technologists and caregivers are eager to use technology to monitor elders, but everyone is punting on more ethical issues, such as privacy:
 - Hobson's choice: an elder can either give up all of their privacy by moving into an assisted living facility, or some of their privacy to the technology.

Privacy Paradigms

- Seclusion
 - Right to be left alone
- Autonomy
 - Right to do what you want
- Property
 - Ownership of data
- Spatial
 - Boundaries

Neither designers
nor elders are
well versed in
privacy.

ETHOS Approach



- Toolkit to assist in privacy-enhancing design:
 - Tools to facilitate communication between designers and elders
 - Tool to ease implementation of design

Living Lab

- 1 bedroom apartment, with living room, kitchen and bath
- Intermediate testing of prototypes in realistic setting

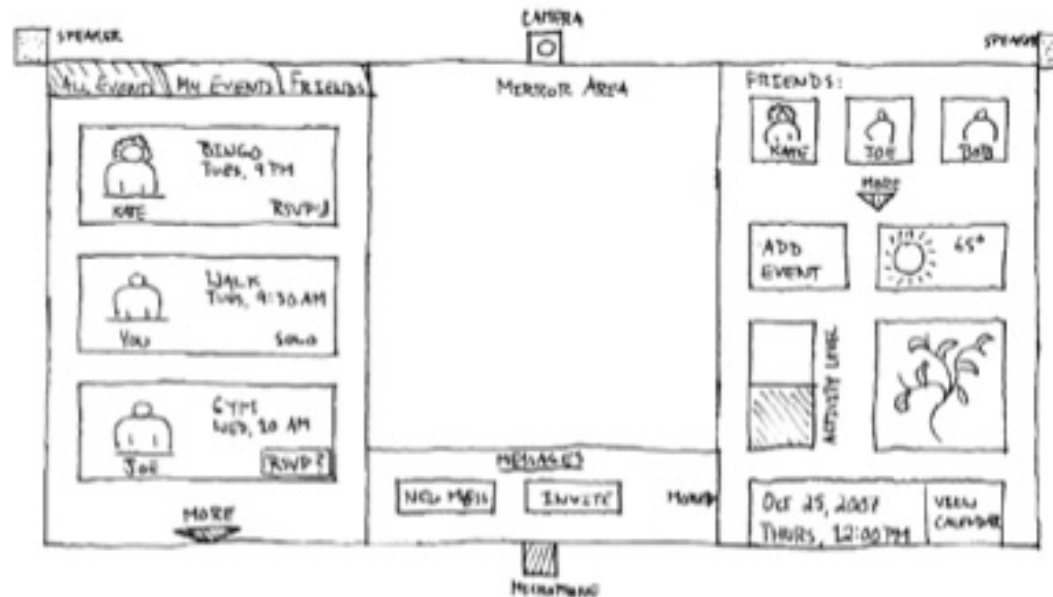


Ambient Plant



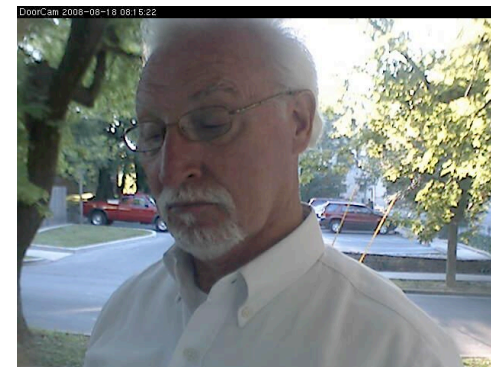
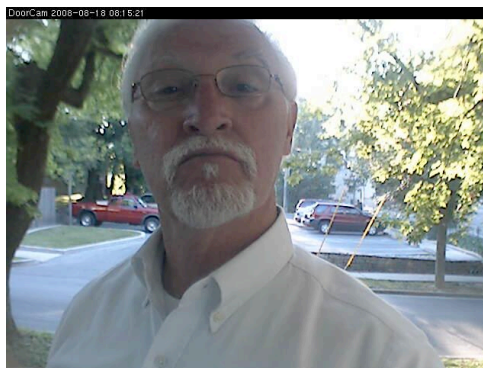
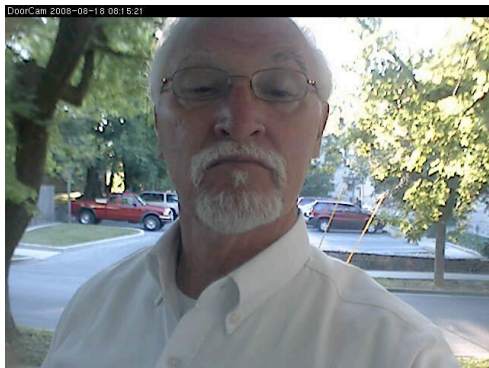
- Awareness of remote presence
- Embedded in existing home object
- Attitudes change after experience

Mirror Motive



- Embedded in everyday object
- Reminders and monitoring
- Inherent trust of system to protect their data

Portal Monitor



- Focus on physical security a positive
- Often more comfortable with pictures taken than motion sensed in ambient plant

Initial Results

- Reciprocity not important for many
- Data as property was a foreign concept, even though that is the legal reality under which they live
- Data granularity not deciding factor (though video was almost universally disliked)
- Longitudinal, in-situ studies

Cultural Differences

- How does culture affect people's attitudes about technology?

- Data protections laws
- Medical infrastructure
- Social/government programs
- Access to transportation
- Family/social structures

Performing focus groups and interviews in United States (Indiana, Georgia) & United Kingdom (Milton Keynes, Glasgow).

ETHOS Team

- Faculty:
 - Jean Camp -- privacy specialist
 - Kay Connelly -- technology
 - Lesa Huber -- elder specialist
 - Kalpana Shankar -- social scientist

<http://ethos.indiana.edu>

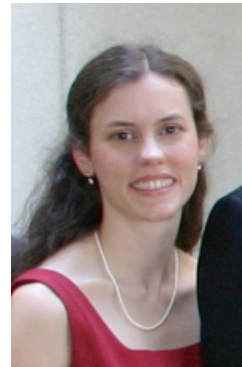
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- Iterative, user-centered design
 - Grounded in behavior theories
 - In-situ, longitudinal testing
 - Develop new methods for eliciting privacy concerns

Announcing....

Institute
investigating
privacy and
security of
pervasive
health
applications



Fred Cate



Kay Connelly



Jean Camp



Steve Myers



Minaxi Gupta



**XiaoFeng
Wang**



Raquel Hill

Funded by the Lilly Endowment

Europe, Oct-Dec, 2008.

Grand Challenges Workshop

- IU will host a workshop
 - Leading researchers from the United States
 - A few international experts
 - To identify the major challenges , and
 - Formulate research agenda for
 - Privacy and security of pervasive health applications

 - Look for it next year