Reaching the Potential of Technology to Support Healthy Aging: From Apps to Robots

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Center for Research and Education on Aging and Technology Enhancement (www.create-center.org)

Technologies to Support Successful Aging with Disability (www.TechSAge.gatech.edu)

National Institute on Aging (National Institutes of Health) PO1 AG017211

National Institute on Disability, Independent Living, and Rehabilitation Research (Department of Health & Human Services) Grant 90RE5016-01-00
Demographic Trends

World Population

Source: Population Reference Bureau

http://www.prb.org/
Percentage of population aged 65 and over in 2010 across the EU


~17%
Percentage of population aged 65 and over in 2035 across the EU

Support Healthy (Successful) Aging

• Allow individuals to
  • function effectively and independently as they age
  • maintain personal autonomy
  • retain and enhance ability to function in later life
  • manage chronic conditions
  • support preventive health (wellness)
Inspirations for Successful Aging
Our Future Selves

Current members of the Human Factors and Aging Laboratory
Same people – AgingBooth app
Human Factors is:
• the study of characteristics of people and their interactions with products, environments, and equipment
• considering needs and capabilities of users in the design of systems, devices, training, instructions, and environments
• “Designing for human use”

The Human Factors and Aging Laboratory Goals:
• Determine abilities, limitations, needs, preferences of older adults
• Contribute to the successful design of technology usable and useful products and systems
  • effective training & instruction
  • optimized deployment and introduction
Know thy User

• Who is **THE** older adult?
  – No such thing
  – Older adults vary widely in:
    • Experiences
    • Attitudes
    • Abilities
    • Goals
    • Limitations
    • Needs
    • Preferences
  – Think in terms of sub-groups and categories of need
Needs Assessment

• Activities of Daily Living (ADLs)
  • Bathing, eating, drinking, mobility

• Instrumental Activities of Daily Living (IADLs)
  • Preparing meals, paying bills, managing medications, maintaining the home

• Enhanced Activities of Daily Living (EADLs)
  • Social communication, hobbies, new learning, work, volunteering, community participation
What changes as people age?

• health
• mobility
• vision, hearing
• cognitive functions
• social interaction
• support needs
Percentage of population aged 60 years or over living independently

<table>
<thead>
<tr>
<th>Region</th>
<th>Men</th>
<th>Women</th>
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<td>Belgium</td>
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From www.un.org
Percentage of People Age 65 and Over Who Reported Having Selected Chronic Health Conditions, 2009-2010 (many individuals have multiple chronic conditions)

- Heart Disease: 30.4%
- Hypertension: 55.9%
- Stroke: 8.6%
- Emphysema: 6.2%
- Asthma: 11.3%
- Chronic Bronchitis: 6.2%
- Any Cancer: 24.0%
- Diabetes: 20.5%
- Arthritis: 51.2%

From: Older Americans 2012 by Federal Interagency Forum on Aging Related Statistics (Indicator 16)
For adults over age 80, the chance of having a disability is 75%.

Theory of Successful Aging: Response to Challenges

SOC Model of Aging

Selection
- Elective Selection – choosing goals
- Loss-based selection – pruning goals

Optimization
- Distribution of existing resources in support of maintaining performance

Compensation
- Using new resources (e.g., technology or outsourcing) to compensate for loss

Baltes & Baltes, 1990
Complexity of Health Self-Management

Person Characteristics

- **Abilities**
  - Cognitive
  - Health literacy
  - Motor
  - Perceptual

- **Attitudes**
  - Goal setting
  - Motivation
  - Perception of risk
  - Self-efficacy
  - Stress

- **Experience**
  - General & specific disease knowledge
  - Prior experience

Potential Facilitators

- Formal Health Care Network
- Social Support Network
- Decision Support Technologies

Technology Demands

- Complexity
- Reliability
- Usability

- How is the information collected, tracked, visualized, shared?

Health Information Characteristics

- Access
- Ease, Immediacy, Security
- Amount
- Complexity
- Criticality
- Integration required
- Presentation Format
- Quantitative, Qualitative

Making Healthy Decisions

Chronic Conditions

General Wellness

Mitzner, McBride, Barg-Walkow, & Rogers (2013)
Opportunity for Technology Supports

- **Potential** and **Challenges**
  - Wellness management technologies
  - Exergames
  - Apps
  - Robotics
  - Sampling of our research in these areas

- **Theme:**
  - Need to design for older adults’ capabilities, limitations, and preferences
Wellness Management: Potential

71% of older adults track weight, diet, or exercise*
  44% keep track in their head
  41% use paper
  12% use a medical device
  2% use a computer program
  1% use an app or mobile tool
Less than 1% use a website or other online tool

Wellness management technologies can support these activities:

• to set and monitor health-related goals
• manage diseases
• maintain health

*Fox & Duggan, (2013)
Acceptance Over Time

• Predictors of wellness management technology use for older adults
  • Change over time
  • Assessed older adults usage over 28 days for two devices
  • Diaries and surveys pre and post

• Participants
  • 16 (8 males, 8 females)
  • Ages 65-75 (M=70.06, SD=3.09)

• Assigned either:
  • Fitbit One
  • myfitnesspal.com
  • (usage and attitude data were similar)

Intent to Adopt

Initial

Final

Total Score

Participant

Adopters

Non-adopters

1=Extremely Unlikely

4=Neither

7=Extremely Likely

1=Extremely Unlikely

4=Neither

7=Extremely Likely

Participant
Perceived Usefulness

![Bar chart showing perceived usefulness scores for adopters and non-adopters at initial and final stages.](chart.png)

- **Initial**
  - Adopters: Mean Score
  - Non-adopters: Mean Score

- **Final**
  - Adopters: Mean Score
  - Non-adopters: Mean Score

*Significant difference indicated by asterisk.*
Wellness Management: **Challenges**

- **Usefulness**
  - Mixture of attitudes
    - potential benefits for promoting exercise and diet habits
    - not better than paper and pencil
- **Usability challenges related to:**
  - system status visibility
  - error prevention
  - consistency and standards
- **Older adults willing to use wellness management technologies, but better design and training required.**
Exergames: Potential

Video games to promote physical activity...may provide physical, cognitive, and emotional benefits

Evaluated two exergame programs for Microsoft Xbox 360 with Kinect

Perceptions generally positive
  
  “good for physical activity”
  
  valuable as a way to “keep active”
Exergames: Challenges

• Current exergames are not developed with consideration of older adult users’ physical and cognitive abilities
  • Difficulties:
    • learning to use gestural controls
    • navigating menus and instructional screens
    • on-screen instructions insufficient
    • not sure when to perform actions
    • perceptual, motor, and cognitive errors

• Need to design games for older adults
• Provide better instruction and training
  • Quick-start guide
  • Evidence-based

Managing Chronic Pain

Small Business Innovative Research Grant with Aptima, Inc. (Camilla Knott)

Collaborators: Pat Parmelee, Terry Fairbanks
Osteoarthritis

• Management is complex

• Many resources for osteoarthritis management exist, but…

...overwhelming amount of information
• Difficult to personalize from general disease model
• Current tools are limited
Stages of Research

- Knowledge requirements
- Available support
- Beliefs about pain factors
- Current approaches
- Prototype system
- Heuristic analysis
- Refine prototype
- Efficacy of system
- Large-scale user testing
- System dissemination

McBride, et al. (2011)
Barg-Walkow, et al. (2013)
SBIR Grant Phase I
Next Steps

Next Steps

SBIR Grant Phase I
Prototype System with Simulated Data

- Improved older adults’ understanding of pain triggers

Judgments about Pain Relationships with Other Variables

Accuracy (% correct)

Older Adults

- Next step: large scale trial of whether STAMP reduces pain
Apps: Challenges

• Most available apps not developed with consideration of older adult users’ physical and cognitive abilities or needs in mind

• Need to understand
  • Information requirements
  • Test comprehension of information displays
  • Assess efficacy of using the apps for health management (e.g., reducing chronic pain)
How do we design robots to support successful aging?

- What do robots need to do?
  - Communicate with humans
    - Show emotions
  - Perform tasks for the person
  - Be trustworthy
  - Have an appearance people like
  - Provide social support

- Categories of Robots
  - Personal Service Robot
  - Social Robot
GATSBII
(GATechServiceBotwithInteractiveIntelligence)

Collaboration with Dr. Charlie Kemp Director of the Healthcare Robotics Lab
Video of GATSBII’s Functionality
• Imagine you need assistance – would you prefer a human or a robot?

• 48 home-based tasks

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<thead>
<tr>
<th>If I needed assistance with...</th>
<th>If I needed assistance, I would prefer help from...</th>
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<tbody>
<tr>
<td></td>
<td>Only a human(^1)</td>
</tr>
<tr>
<td>a. Bathing</td>
<td>1</td>
</tr>
<tr>
<td>b. Being entertained (e.g., playing games, dancing)</td>
<td>1</td>
</tr>
<tr>
<td>c. Being reminded of appointments</td>
<td>1</td>
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</tbody>
</table>
Activities of Daily Living

- Shave
- Hair care
- Bathe
- Eat
- Dress
- Brush teeth
- Walk
- Prepare meal
- Call family/friends
- Decide medication
- Take medicine
- Call doctors/911
- Grocery shop
- Wash dishes by hand
- Remind take medicine
- Laundry
- (Un)load dishwasher
- Take out trash
- Make bed
- Change light bulb
- Clean bathroom
- Clean window
- Control pests
- Clean floor
- Clean kitchen
- Entertain guests
- Be entertained
- Exercise
- Learn new skills
- Getting hobby info
- Learning use new technology
- Get weather/news

Assistance Preference – Robot vs. Human?

- Only Robot
- Only Human
- No pref

Preferences vary depending on the activity.
Instrumental Activities of Daily Living

Assistance Preference – Robot vs. Human?

- Only Robot
- No pref
- Only Human

Activities include:
- Prepare meal
- Call family/friends
- Decide medication
- Take medicine
- Call doctors/911
- Grocery shop
- Wash dishes by hand
- Laundry
- Remind take medicine
- (Un)load dishwasher
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- Entertain guests
- Be entertained
- Exercise
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- Learning use new technology
- Get weather/news
**Assistance Preference – Robot vs. Human?**

- **Entertain guests**
- **Be entertained**
- **Exercise**
- **Learn new skills**
- **Getting hobby info**
- **Learning use new technology**
- **Get weather/news**

**Enhanced Activities of Daily Living**

- Only Robot
- No pref
- Only Human
Activities of Daily Living

Instrumental Activities of Daily Living

Enhanced Activities of Daily Living

Assistance Preference – Robot vs. Human?
Delivering Medication (video)

Clearing away clutter

Learning Light Switches
Older adults were:
- Very positive about the robot
- Not at all frightened
- Excited about the potential for the future
Attitudes more Positive after Interaction Experience

**Being Reminded to Take Medication**

- **Before (PRE)**: Mean (M) = 2.75, Standard Deviation (SD) = 0.97
- **After (POST)**: Mean (M) = 3.42, Standard Deviation (SD) = 1.51

**Delivering Medication to You**

- **Before (PRE)**: Mean (M) = 2.50, Standard Deviation (SD) = 1.24
- **After (POST)**: Mean (M) = 3.17, Standard Deviation (SD) = 0.58
Personal Service Robot: Challenges

- Acceptance by older adults
  - Trust
- Design for home spaces
- Reliability, consistency, transparency
- Maintenance
- Cost
Social Support Robot: PARO

- Designed by Dr. Takanori Shibata – to elicit happiness and relaxation
  - Modeled after a baby harp seal
    - Moves and makes similar sounds

- Tactile sensors: paws, back, head, chin, whiskers
- Ability to sense light, touch, and sound
Social Support Robots: Potential

Do healthy older adults’ perceive Paro as being useful in their daily lives?

Who might Paro be used by?

How might Paro be used?

Overall, participants had positive attitudes toward Paro

- Of the 30 participants, most perceived Paro as being useful to themselves and beneficial to people in general

**Perceptions of Usefulness**

- Useful to you?
  - Maybe: 1
  - No: 11
  - Yes: 18

- Beneficial to people?
  - Maybe: 6
  - No: 1
  - Yes: 23

“Right now, no. I wouldn’t. Say another year from now, I might lose some of my functions, my legs or something.”

“I think it would be very comforting, and if I feel angry or distressed I think he would be a very good pick-up, definitely a good pick-me-up.”

“I suppose if they were desperate for interaction Paro could fill a gap. I don’t have that feeling as it pertains to myself.”

“Yes, I could see especially with older people who are alone… either living on their own or in housing where pets aren’t allowed.”
Types of Functional Uses Mentioned

- Of the functional uses, mentions of either physical or verbal interactions were most prevalent.

- “I’d just hold him and pet him and whatnot.”

- “If you need to vent, vent to Paro.”

- “I’d have it close by... it makes me know that there is somebody else or something else around.”
Likes: Physical Personality
Engagement and Affect

Active Engagement with PARO

- Words Spoken
- Move
- Gesture
- Pet
- Smile
- Touch

Amount of engagement predicted positive affect at the end of the study
Social Support Robot: Challenges

- Limited research on whether PARO is effective at reducing stress, providing companionship

- Characteristics of social/companion robots
  - Appearance
  - Interaction methods
  - Responsiveness
  - Learning about person
  - What makes them effective
Conclusion

• Current technologies can support health and well-being of older adults
  • Design adaptations
  • Training
  • Proper introduction into everyday lives

• Emerging technologies have tremendous potential but success depends on:
  • understanding older adults’ capabilities, limitations, needs, preferences, attitudes, and goals
  • involving older adults in process of development and testing
Forthcoming:
Technologies for Assisted Living Communities (2016)
Transportation Systems (2017)
New Adventure and Invitations

• Effective January 2017
• University of Illinois
• College of Applied Health Sciences
• New initiative on Aging, Technology, and Health
  • Planning to build a new smart home research facility
  • Currently recruiting for:
    • Post-doctoral Research Fellow
    • Graduate Students
    • Lab Manager
• Please come visit!
Health Care Technologies for Older Adults: Design, Adoption, Implementation & Training Issues

CREATE Workshop
February 23rd & 24th, 2017
Miami, Florida

(Contact: Adrienne Jaret
ajaret@med.miami.edu)
DESIGN DISABILITY

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Merci Beaucoup!

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