Designing Technologies to Enable Aging-in-Place

Wendy A. Rogers, Ph.D.

School of Psychology, Georgia Institute of Technology

Overview of Presentation

- Description of Aware Home
- Overview of various research themes
- Focus on aging-in-place
  - Human Factors & Aging Laboratory
  - Age-related changes
  - Technology acceptance
   - Robots & intelligent agents

Aware Home Research Initiative

- Aware Home
 - Provide the home with **intelligence and awareness** to support activities of the people living there

Interdisciplinary Approach

Nursing

Telemedicine

Architecture

Human Computer Interaction

Economics

Industrial Design

Computational Perception

Engineering

Public Policy

Human Factors /Engineering Psychology

Gerontology

Assistive Technology
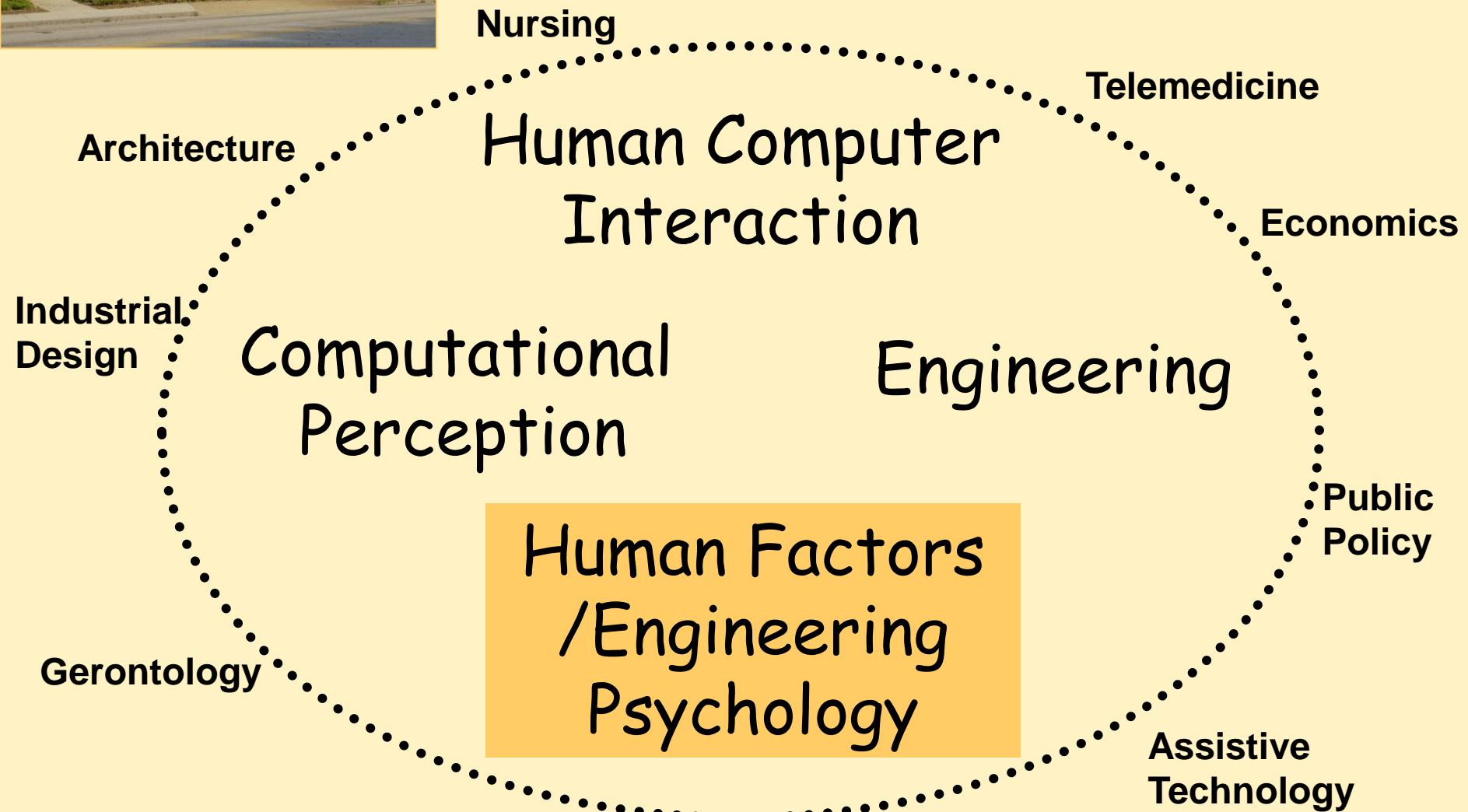
How is awareness accomplished?

- Monitoring systems
  - Cameras
  - Sensors
    - Motion detectors
    - RFID
    - Weight
  - Microphones
- Speakers
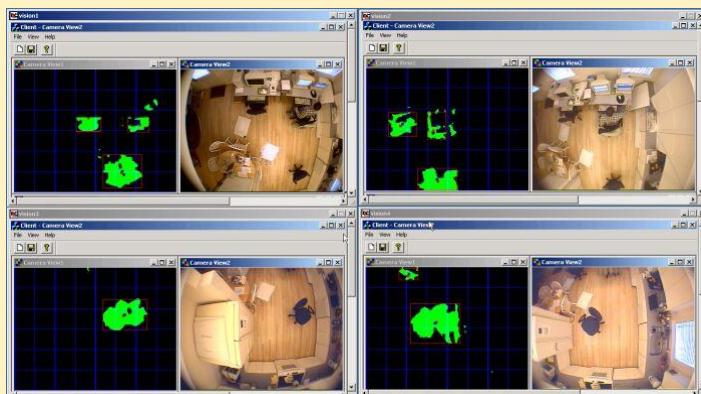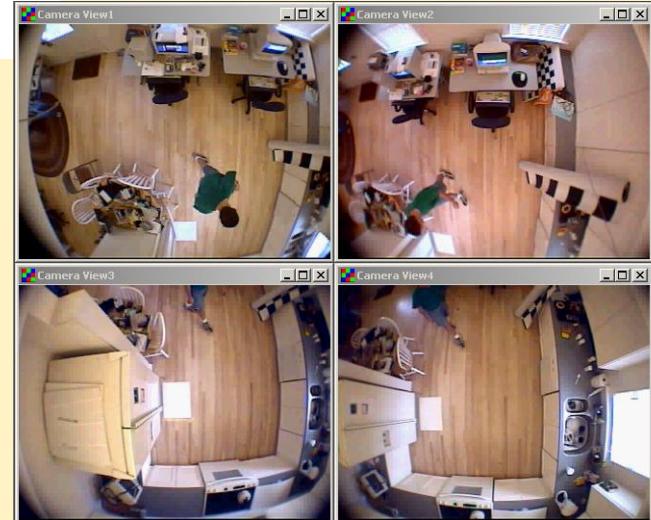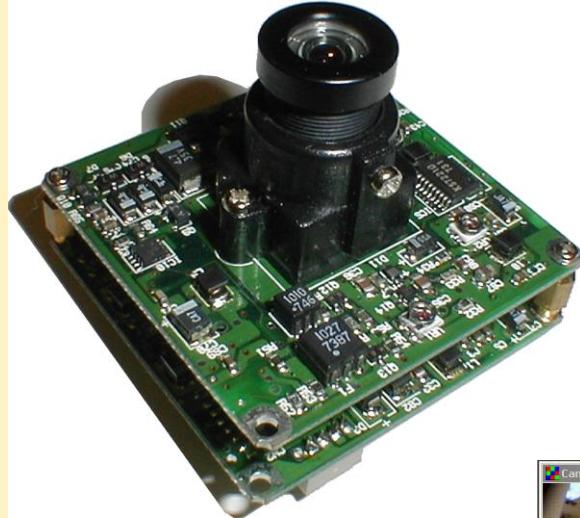
Support Systems throughout House

Current Projects

- Technology Development
  - "Building Blocks"
  - Infrastructure
  - Sensing capabilities
  - Critical for enabling applications
- Technology Applications
  - Tools for busy families
  - Support for social or behavioral disorders
  - **Aging in Place**

Technology Supports for Aging in Place

Human Factors and Aging Laboratory

Human Factors is: study of characteristics of people and 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."

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The Human Factors and Aging Laboratory is oriented toward developing a fundamental understanding of aging, cognition, and attention and bringing that basic knowledge to bear on design issues important to the quality and safety of activities of daily living encountered by older adults.

Human Factors approach to Aging in Place

- Understand user
  - Capabilities & limitations
  - Needs assessment
  - Preferences and attitudes
- Identify potential solutions
- Involve older adults in process of development and testing

Adults Over Age 65

Approximately 7.3% of world population in 2005

(United Nations Demographic Yearbook, 2005)
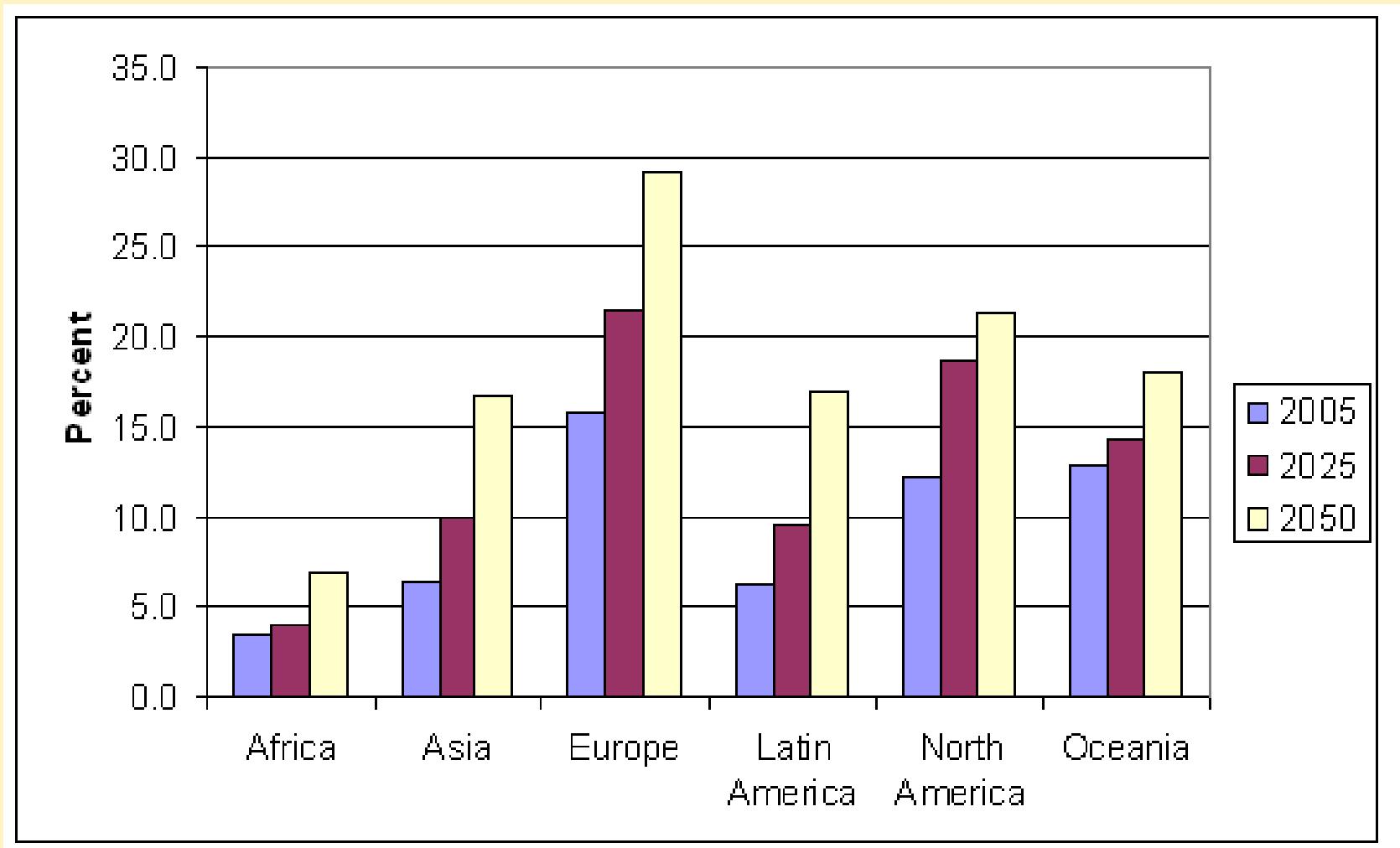
Percent of older adults living alone
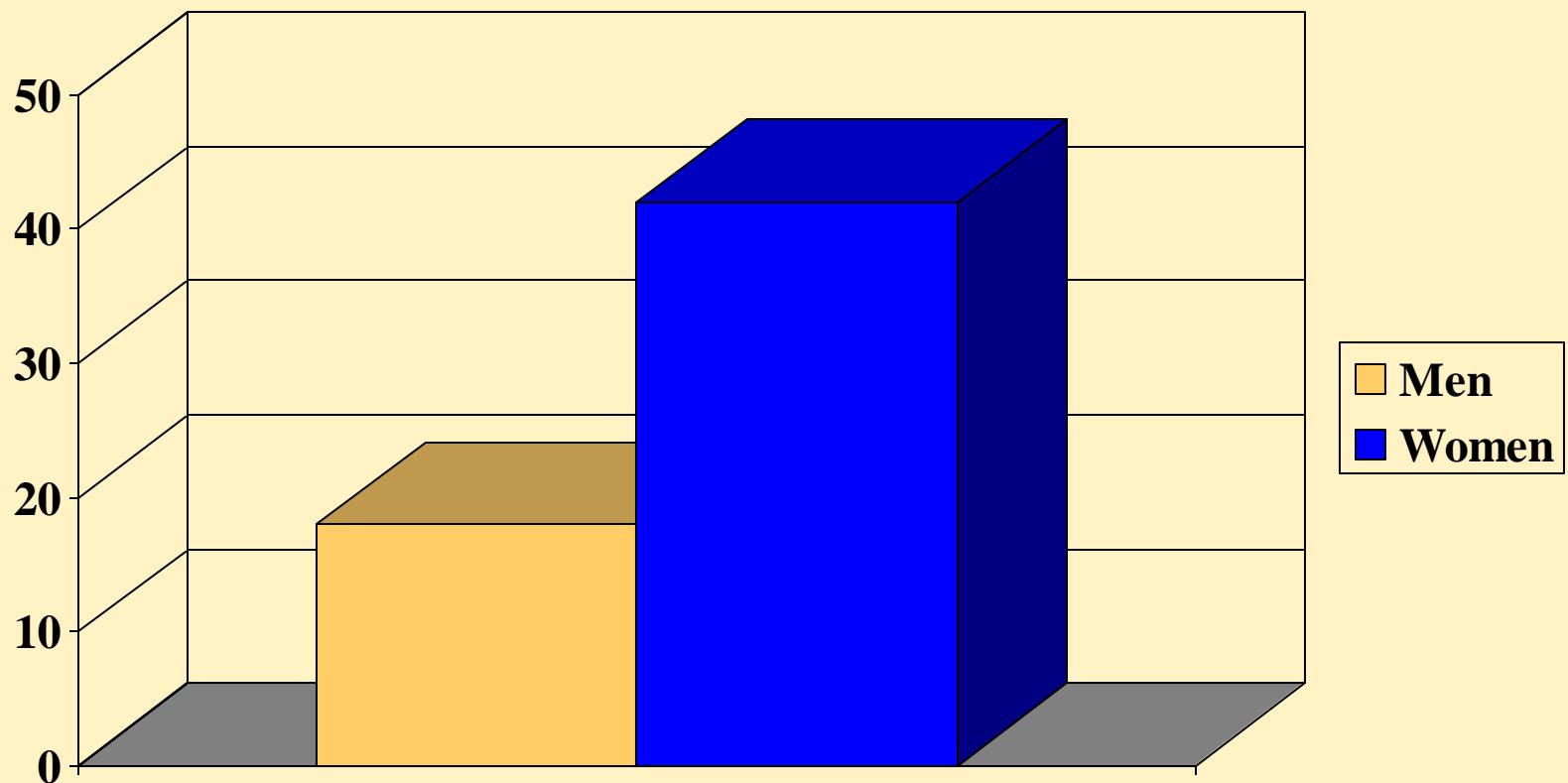
Prevalence of Chronic Conditions for Adults over Age 65 (rate per 100)

Source: http://www.cdc.gov/nchs/agingact.htm

Sensory & Perceptual Changes
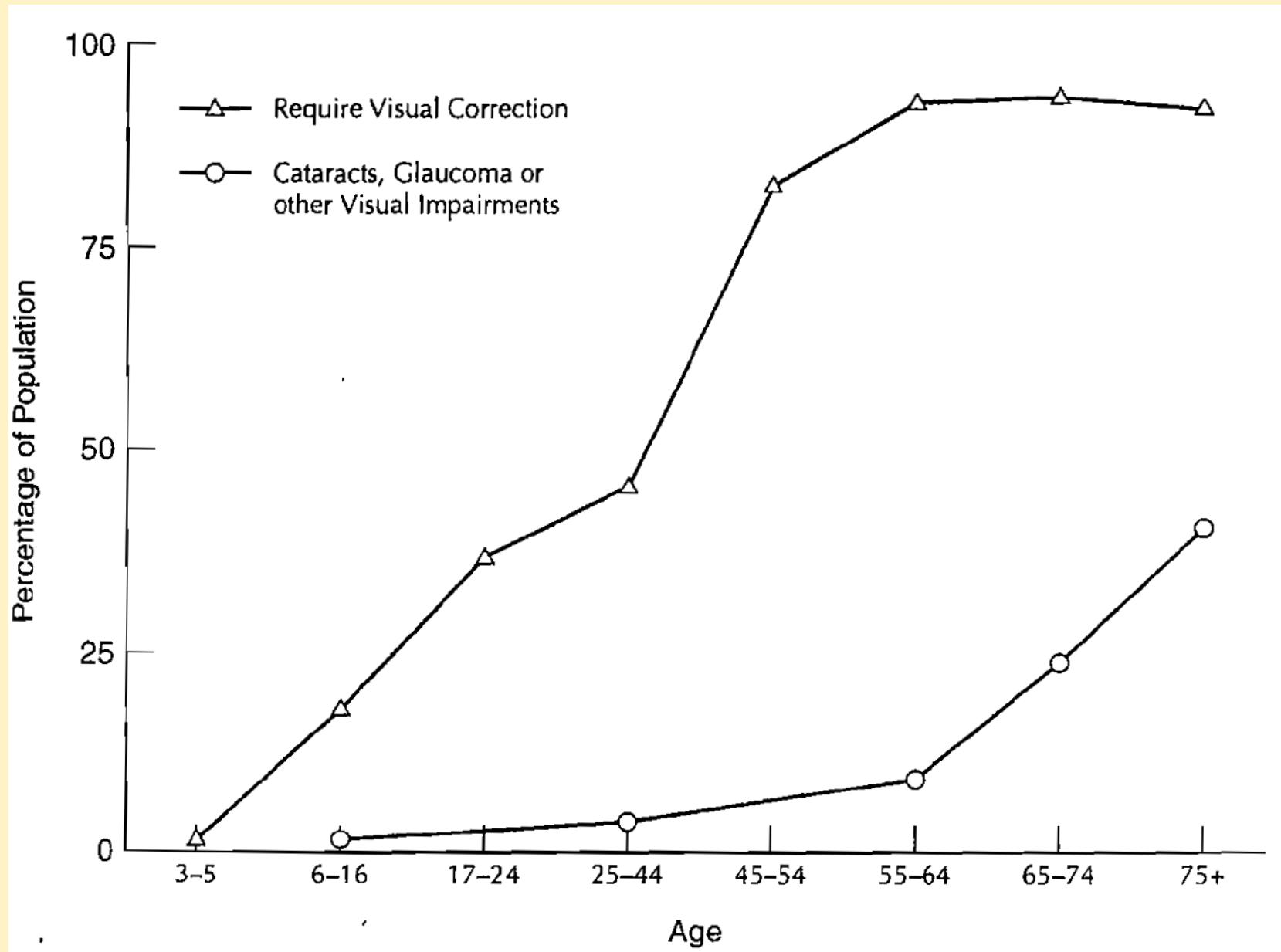
Schaie (2004)

Speech Intelligibility

1. Normal Speech

2. Speeded speech (2x)

3. Selective listening

4. Echoed speech

5. Interrupted speech

Schaie (2004)
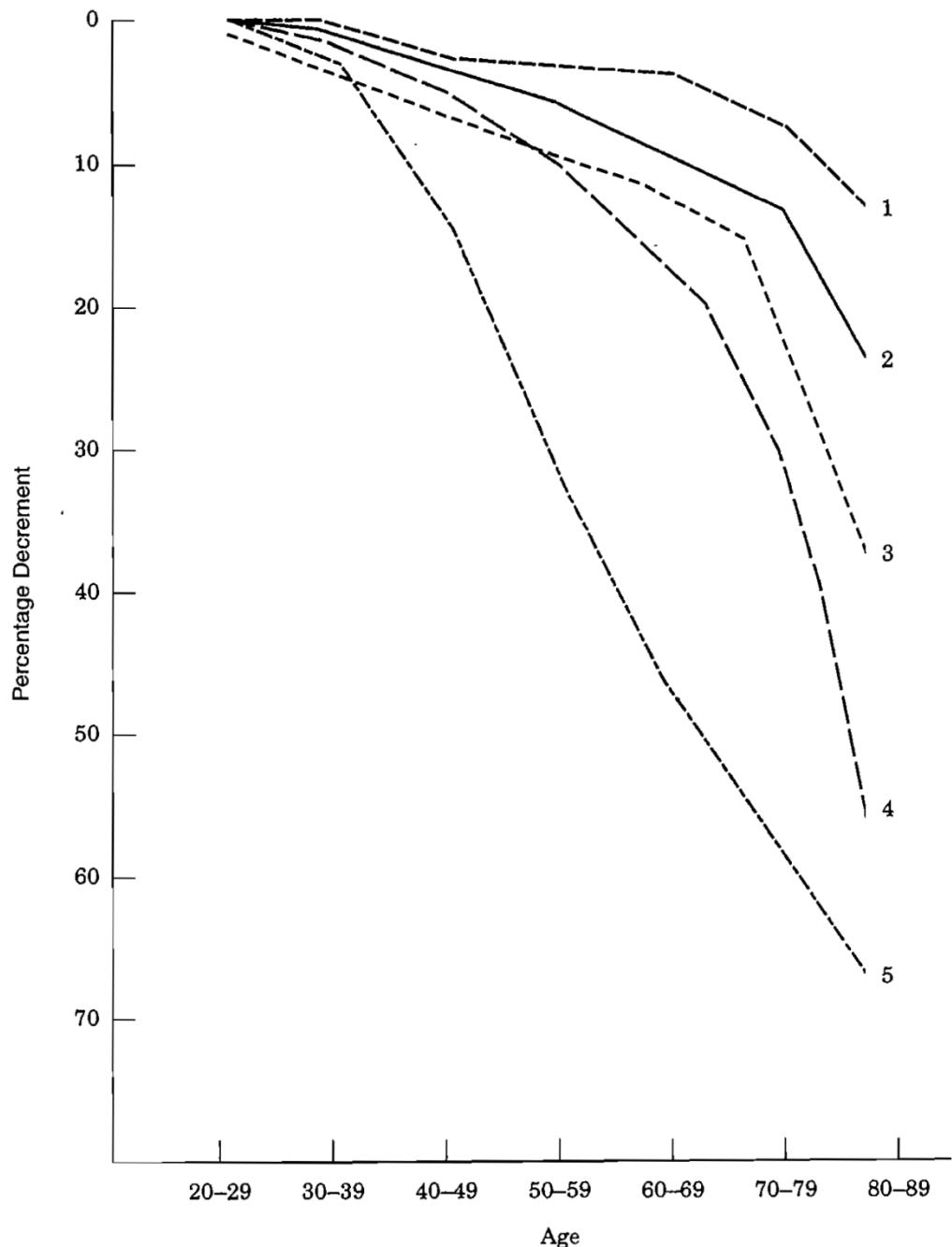
Cognitive Changes (longitudinal data)

Sources: Christensen et al. (1999); Finkel et al. (2003); Hertzog et al. (2003); Schaie (2005); Wilson et al. (2002)
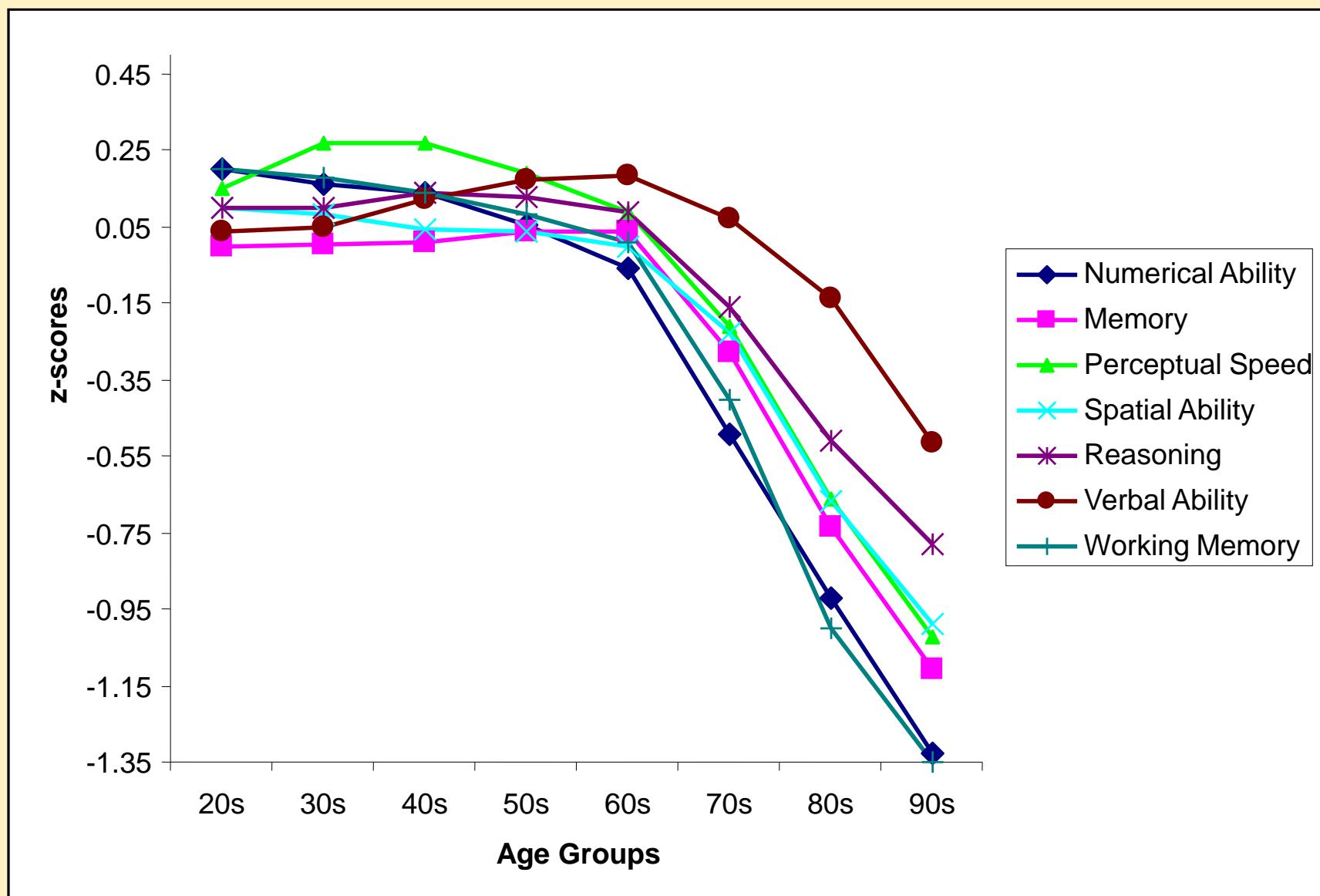
Perceptual Speed
Digit Symbol Substitution (CREATE N=1202)
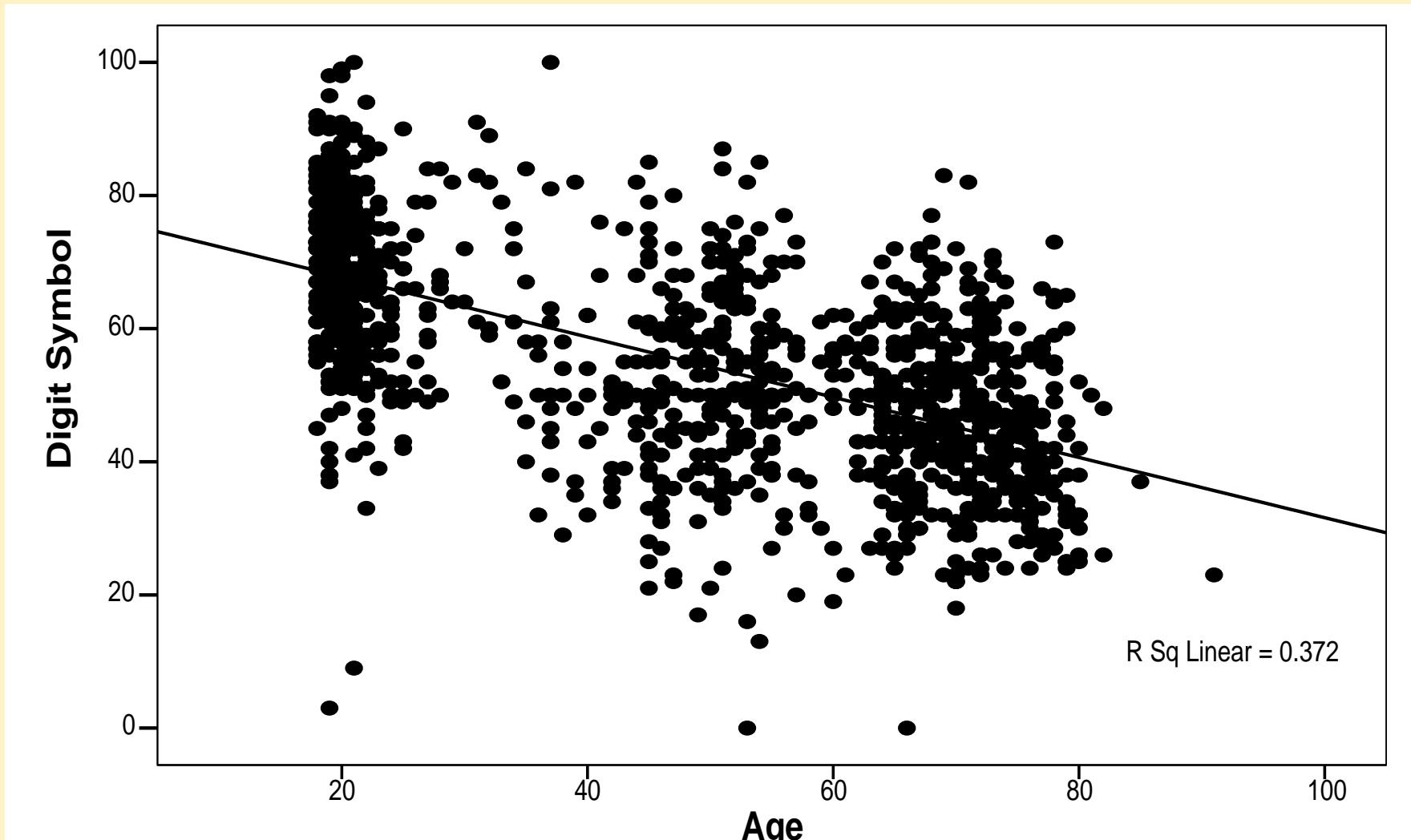
General Knowledge
WAIS Information (CREATE N=1202)
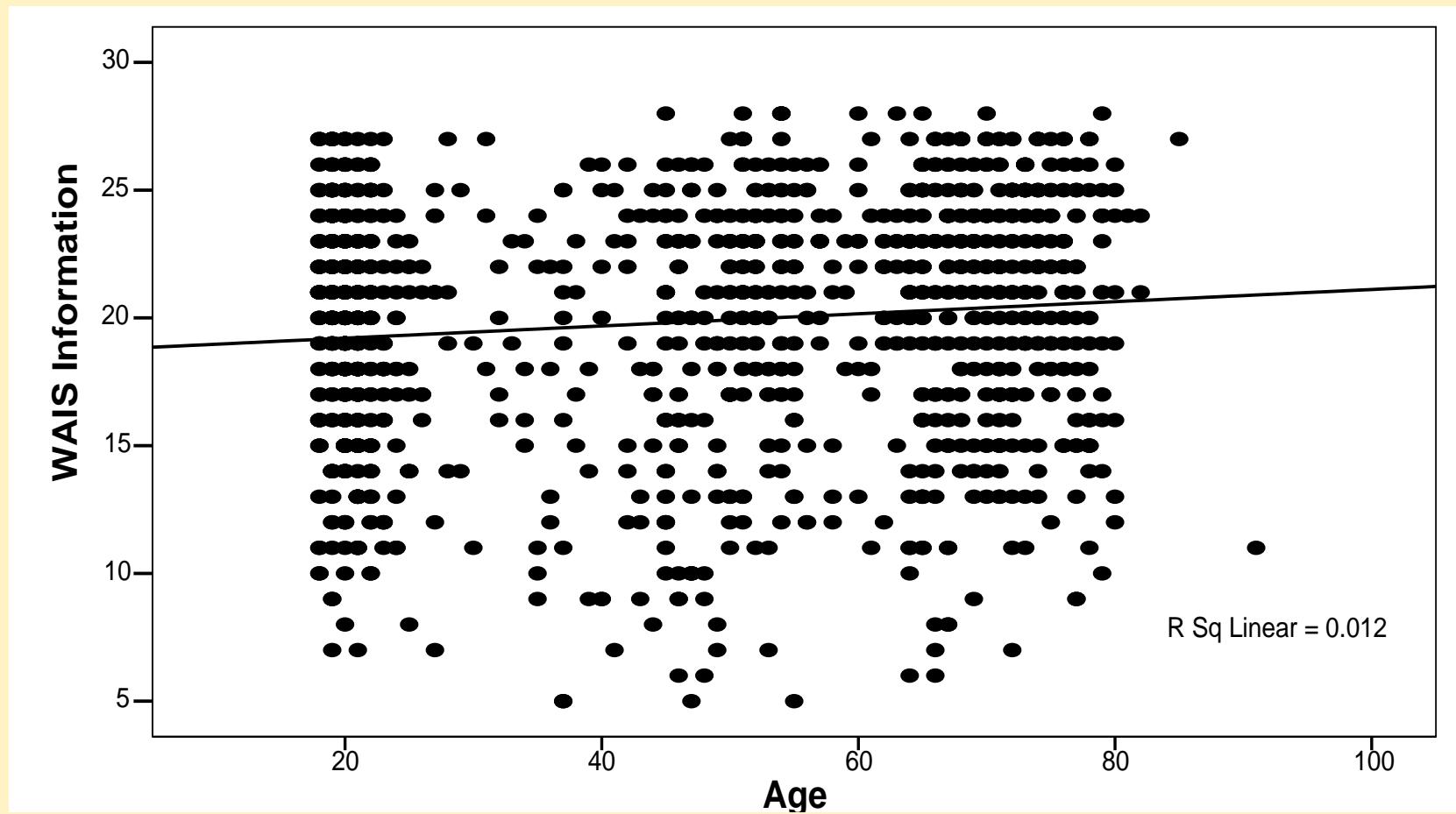
Maintaining Independence

- 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

How best to design technologies to support independent aging?

One avenue of exploration….robotics and intelligent agents

Potential for Robots in Homes of Older Adults

Examples of robots currently available or under development

Activities of Daily Living

- Bathing
- Eating
- Mobility
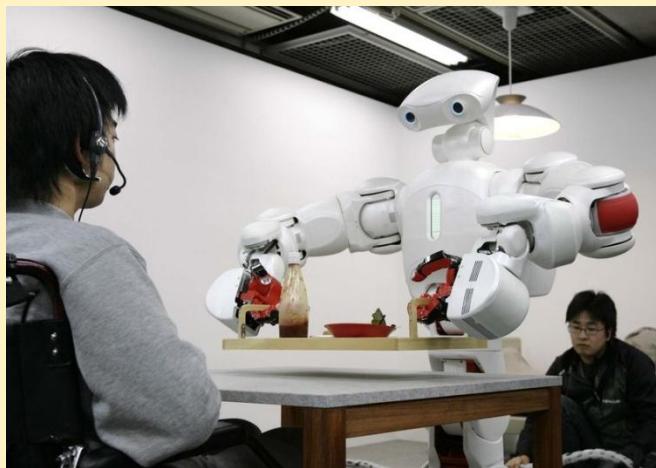
Instrumental Activities of Daily Living

- Home cleaning
- Home/yard maintenance
- Paying bills
- Managing medications

Enhanced Activities of Daily Living

- Social Communication
- Hobbies
- New Learning

"Potential"

- Wide range of "robots" and other agents
- Most current work:
  - Testing the technology
- Not enough focus on the human side of the interaction

Acceptance of Technology

- Technologies are only useful if older adults are willing to use them

- Attitudes

  – Identify barriers to adoption

  – Intrusiveness, privacy, security concerns

  – Conditional adoption

What Influences Technology Acceptance?

- We identified many relevant variables [32] from a detailed review of the marketing, psychology, management, and human factors literatures and our own research.
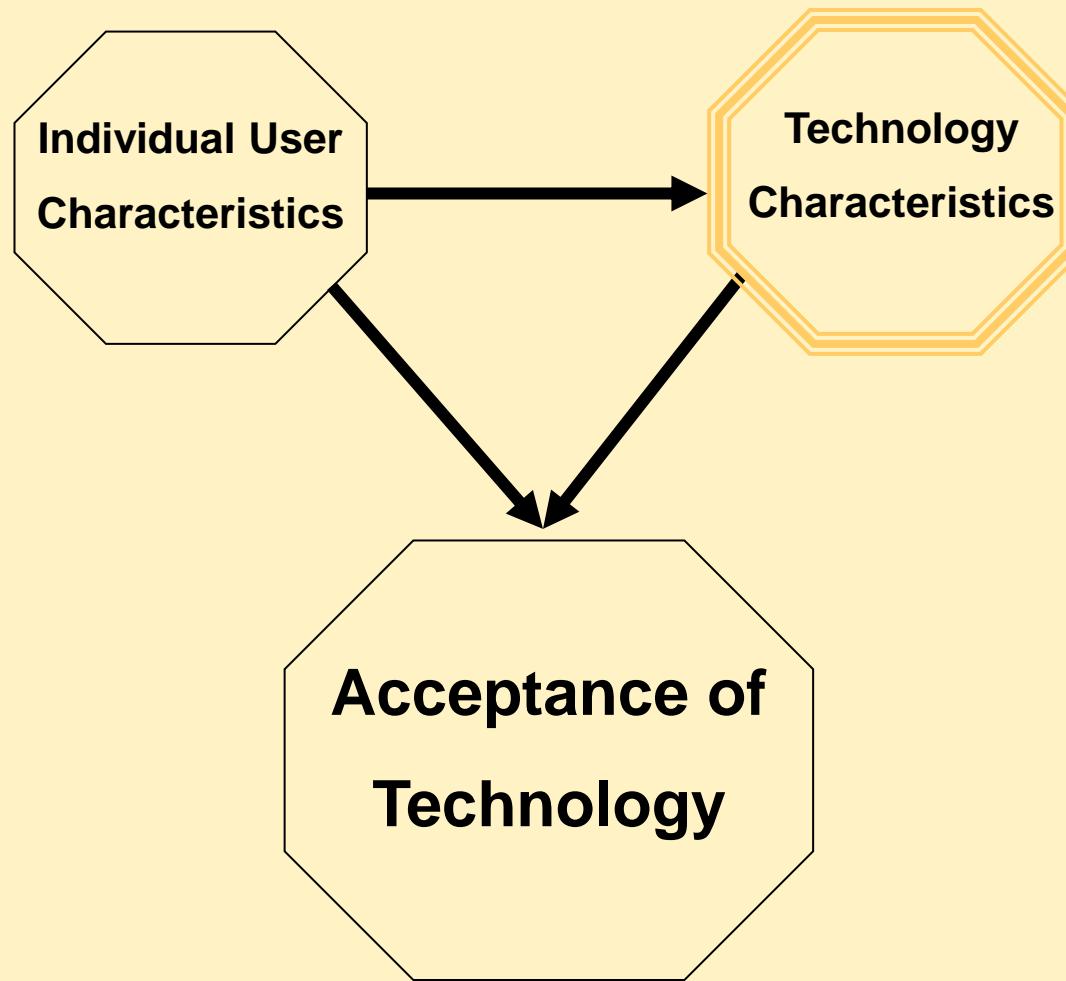
Technology Characteristic	Definition
Perceived compatibility	The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters
Perceived complexity	The degree to which an innovation is perceived as difficult to understand
Perceived ease of use	The degree to which the potential adopter expects a technological innovation to be free of effort in use
Perceived image	The degree to which potential adopters believe the adoption of an innovation will bestow them with added prestige in their relevant community (i.e., relative advantage)
Perceived observability	The degree to which the results of an innovation are visible to others

Sources: Davis (1986); Moore and Benbasat (1991); Rogers (2003)

Technology Characteristic	Definition
Perceived relative advantage	The degree to which an innovation is perceived to be superior to current offerings
Perceived demonstrability	The degree to which the benefits and utility of an innovation are readily apparent to the potential adopter
Perceived trialability	The degree to which an innovation may be experimented with on a limited basis
Perceived usefulness	The extent to which a technological innovation is expected to improve the potential adopter's performance
Perceived visibility	The degree to which an innovation is visible during its diffusion through a user community
Perceived voluntariness	The extent to which innovation adoption is perceived to be under the potential adopter's volitional control

Sources: Davis (1986); Moore and Benbasat (1991); Rogers (2003)

# Understanding Attitudes towards Robots

Some people's attitude towards robots…


Saturday Night Live, November 1995

Video is (1 m 50 s)

Critical Human Factors Question
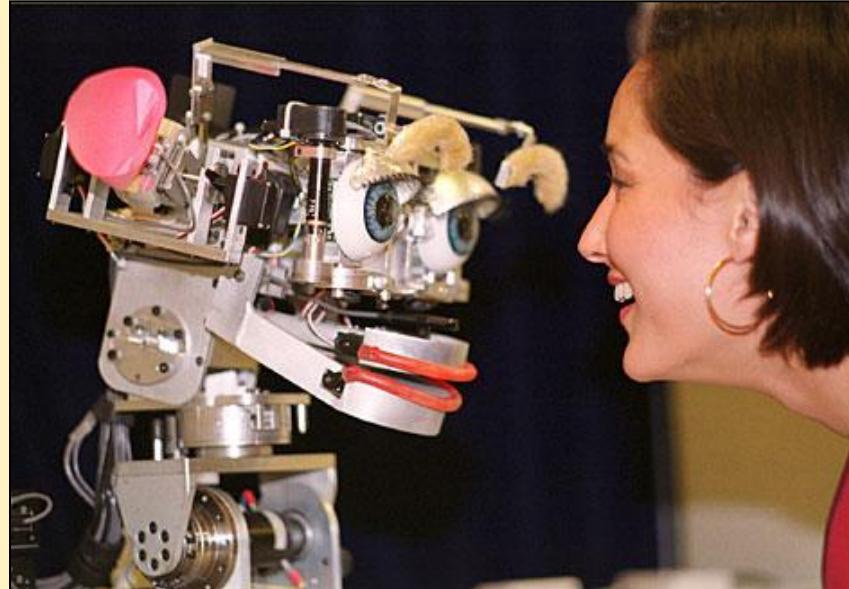
- As robots become more advanced, how should they interact and communicate with humans?

- **Human Robotic Interaction (HRI):**
  - collaboration of computer science, engineering, and human factors psychology

Design Considerations
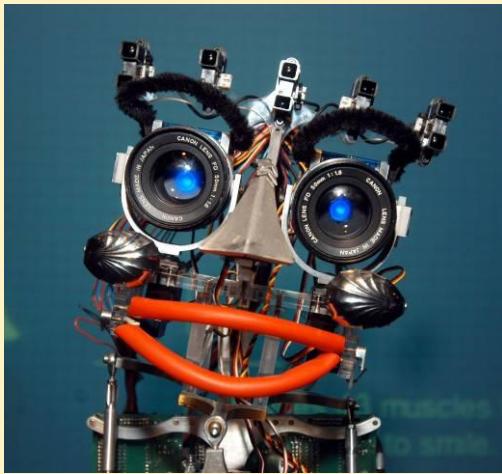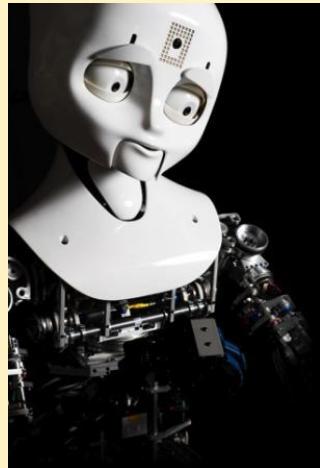
- Adaptability
- Appearance
- Autonomy
- Believability
- Emotion Display
- Intelligence
- Social Interaction

Open Research Issues

- What should robots be designed to do?

- What types of robotic support are older adults willing to accept?

- How important is physical (vs. virtual) presence?

- How do task demands interact with robot capabilities?

- Need theoretical framework to guide successful human-robot interactions.

Identifying Relevant Variables
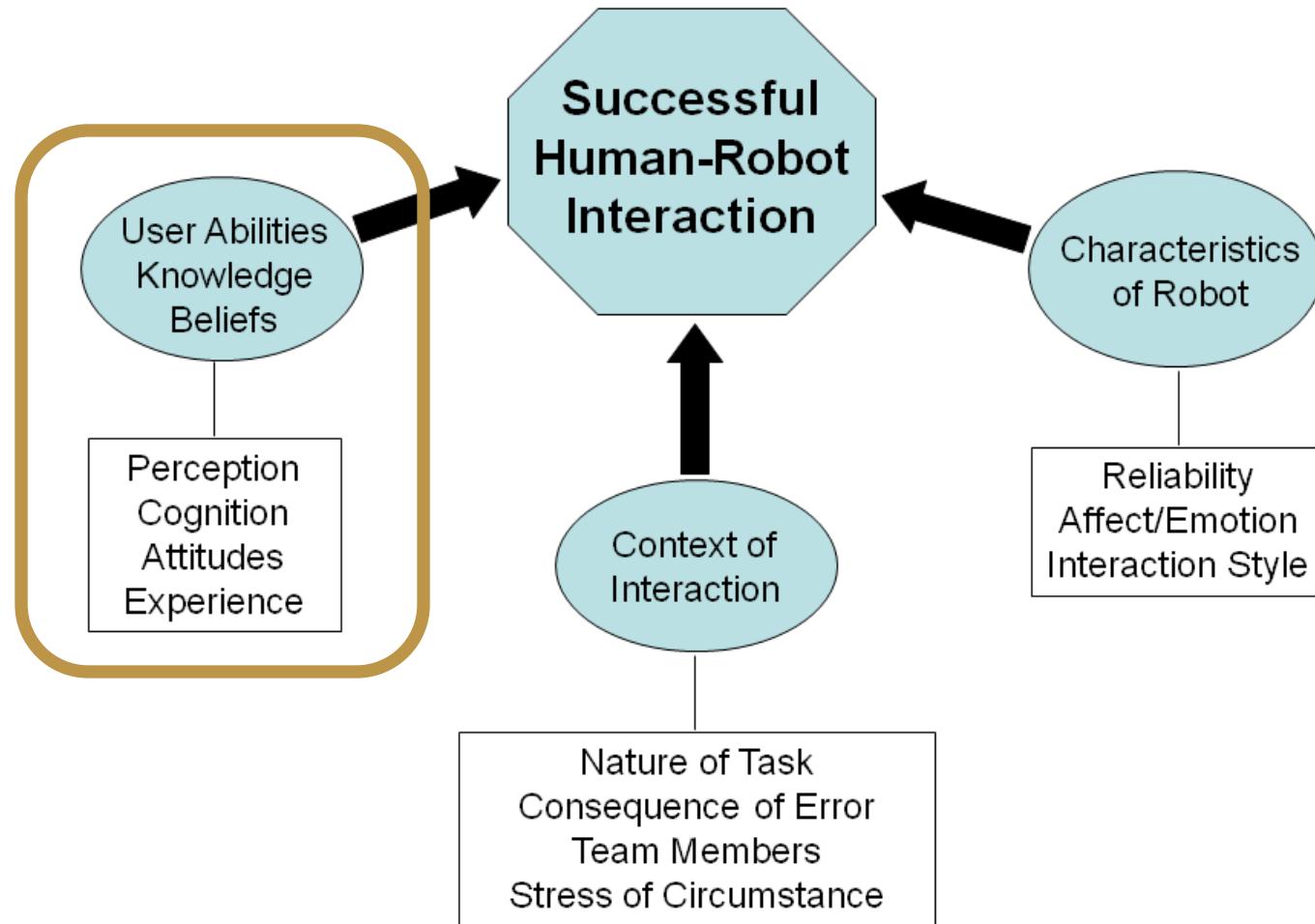
Is a robot an appliance, teammate, or friend? Age-related differences in expectations of and attitudes toward home-based robots
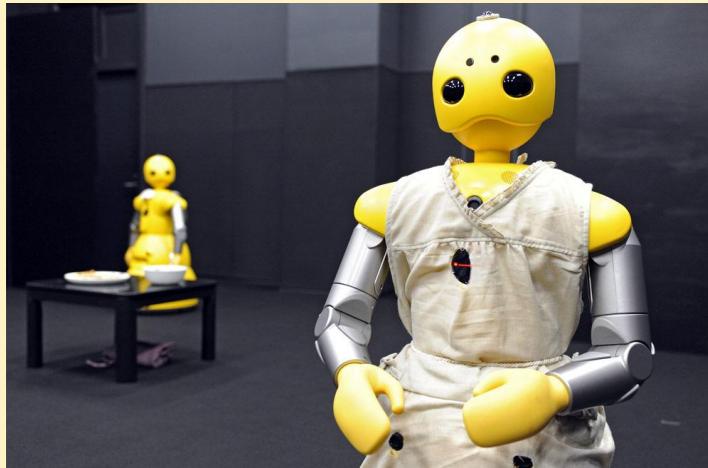
Neta Ezer

Dissertation
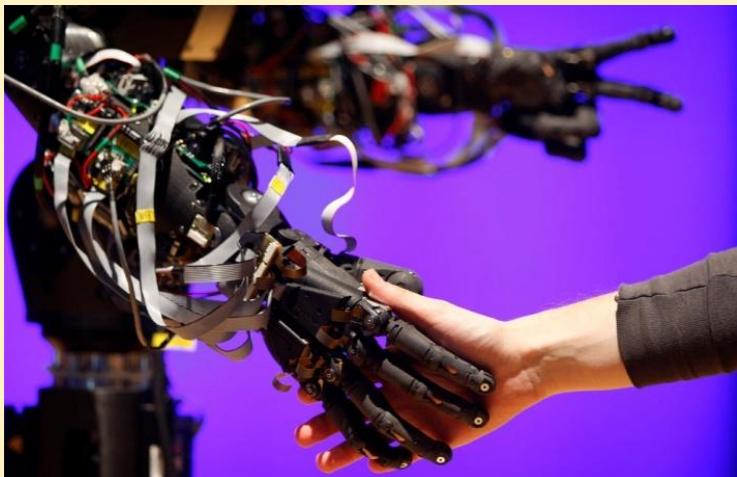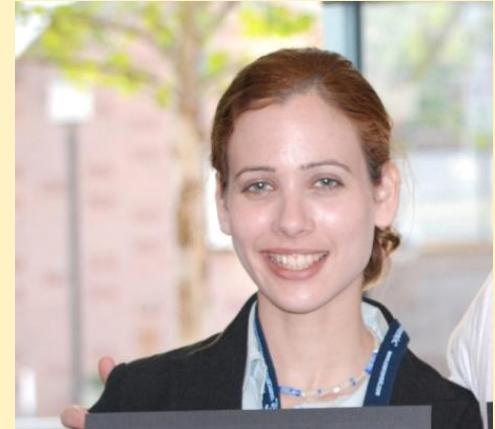
Ezer, N., Fisk, A. D., & Rogers, W. A. (2009). More than a servant: Self-reported willingness of younger and older adults to having a robot perform interactive and critical tasks in the home. *Proceedings of the Human Factors and Ergonomics Society 53rd Annual Meeting* (pp. 136-140)*.* Santa Monica, CA: Human Factors and Ergonomics Society.

Subset of Research Questions

- What characteristics & roles do individuals expect a robot in their home to have?

- What tasks do individuals expect a robot in the home to do?

- Are there age-related differences in expectations of and attitudes toward home-based robots?

Survey Study

- Robot Descriptions and Drawings
- Section I: Views about Robots
- Section II: Robot Tasks
- Section III: Technology/Robot Experience
- Section IV: Demographics and Health
- 60 younger adults (18 -25 yrs)
  & 117 older adults (65-86 yrs)

Imagine someone gives you a robot for your home. Please take a few minutes and try to form a picture in your mind about what the robot looks like, acts like, and does in your home.

Please <u>describe</u> the robot as you imagine it in your home.

Please <u>draw</u> the robot as you imagine it in your home.
*(We will not be judging you on your drawing skills –
just do the best you can).*

Robot Drawings & Descriptions
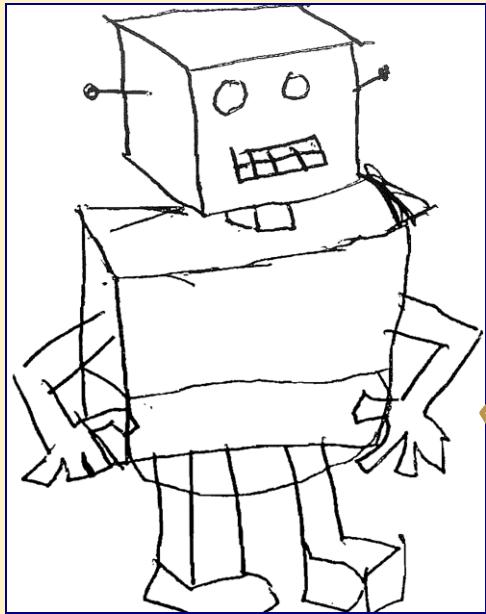
A robot in my home would be **useful** and **multi-purposed**. It would have **internet capabilities**. I imagine it similar to smarter child, the AIM Bot. It could **help with chores, homework, general database**, like 411. It would be a **security system**. It could also **entertain me** when I was bored. I've always imagined a robot like the one from the Jetsons cartoon show.

Younger Adult

Useful. **Cleaning**. **Lifting heavy objects**. **Reaching** high places. For some reason I see a **helpful** robot with a **smiling** face.

Older Adult
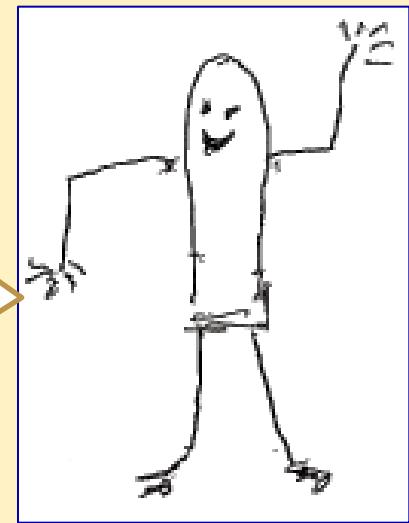
Robot Drawings & Descriptions

human looking

I imagine something **like the movie** I, Robot. It will **clean** and **do chores**. Perhaps I am thinking too much in the future? It should basically **make daily chores easie**r for every household. It should do whatever it can to **make life easier** for people

Younger Adult

If I had a robot, it would be **small** and **compact**. It would **clean** flat, horizontal or vertical surfaces with **brushes** that would **clean crevices, dusting, vacuuming, & scrubbing**. It would **receive automatic updates** that would not interrupt its performance like it does on my computer.

Top Side Bottom
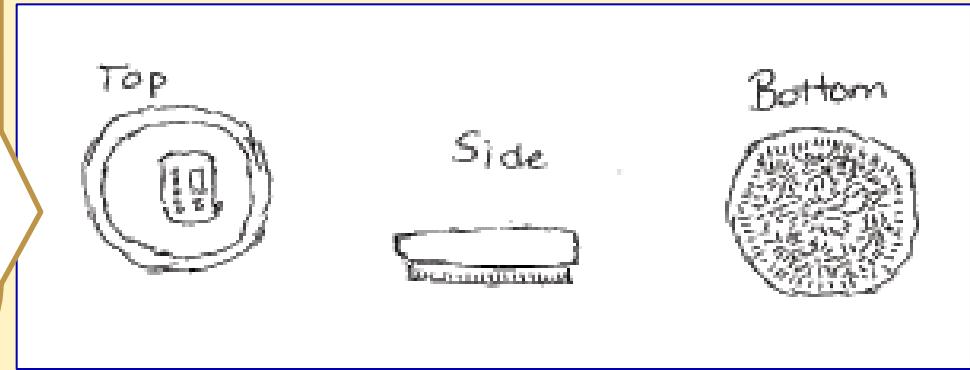
Younger Adult

Robot Drawings & Descriptions
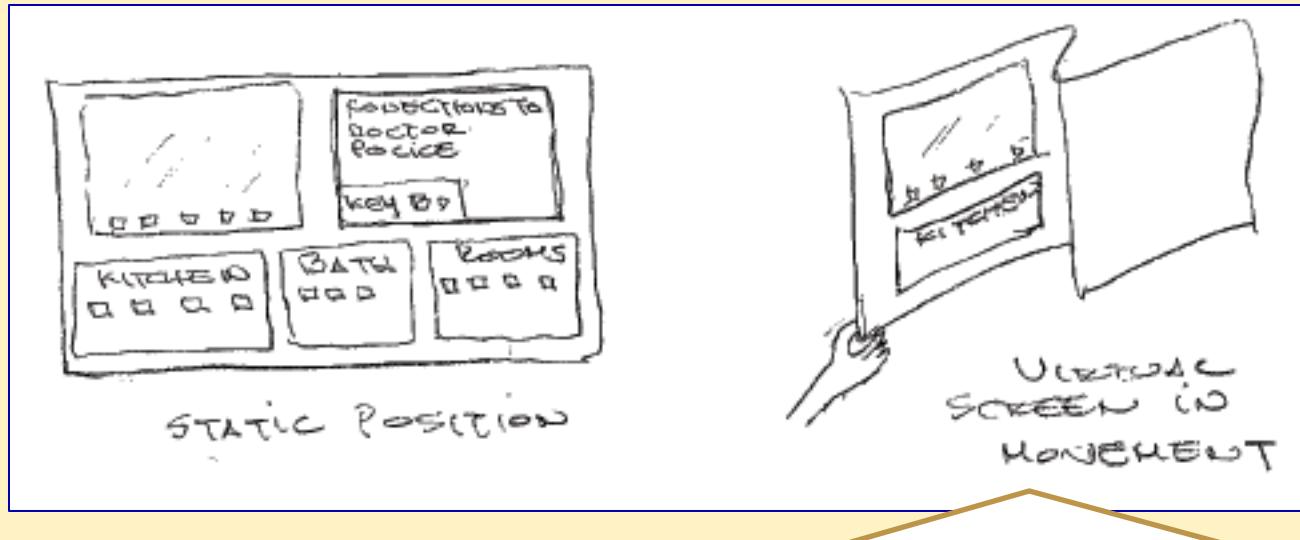
The robot is a **virtual screen**, which I can move from room to room, only using the tip of my finger. On that virtual screen I have **buttons for everything**. **Control the house temperature, turn on/off lights, check all functions of the house** like food in the kitchen closets, refrigerator, etc. The virtual screen needs to have a **TV/computer type screen** and a **telephone line**. (It) should be **connected to my doctor's office** where they could check at my discretion my blood pressure, temperature, etc. It should **give me messages**, wherever I am, if something is wrong (in the) house.

Older Adult

Tasks mentioned in descriptions

- Other 11%
- Conversation 3%
- Cognitive Aid 3%
- Health 3%
- Service 3%
- Maintenance/Repairs 5%
- Cooking 7%
- Work w/ other machines 8%
- Physical Aiding 8%
- Security 10%
- Cleaning/Chores 33%
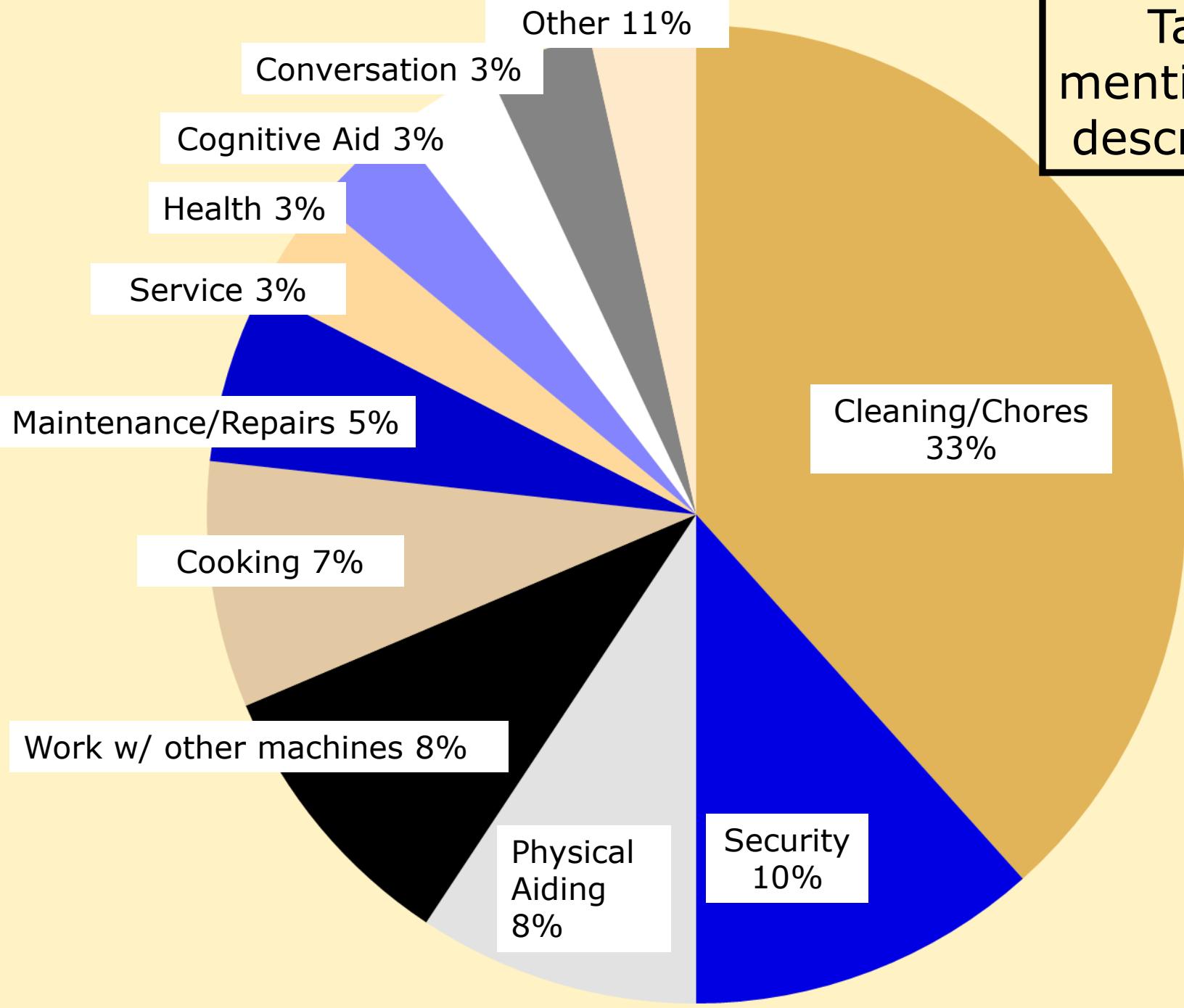
Robot Drawings & Descriptions

- Participants did not have difficulty imagining a robot in their home
    - Pictures and descriptions quite detailed
- Overall, more machine-like robots than human-like robots
    - Younger adults imagined more human-like robots than did older adults
    - Shorter than average human
    - 77% had arms, 89% mobility features
- Cleaning/chores most common tasks mentioned

Factor Structure of Robot Characteristics

Performance-Oriented Traits	Socially-Oriented Traits	Non-Productive Traits
Efficient	Unfeeling	Unpredictable
Reliable	Compassionate	Wasteful
Precise	Unimaginative	Chaotic
Helpful	Unsocial	Risky
Coordinated	Expressive	Demanding
Useful	Friendly	Clumsy
Safe	Dull	Selfish
Quiet	Playful	Nervous
Calm	Creative	Lazy
Sturdy	Lifelike	Breakable
Agreeable	Artificial	Careless
Confident	Boring	Hostile
Trustworthy	Motivated	
Serious	Talkative	
Dynamic		

How much each word matches the characteristics of the robot they imagined
*1="not at all" to 5 = "to a great extent"*
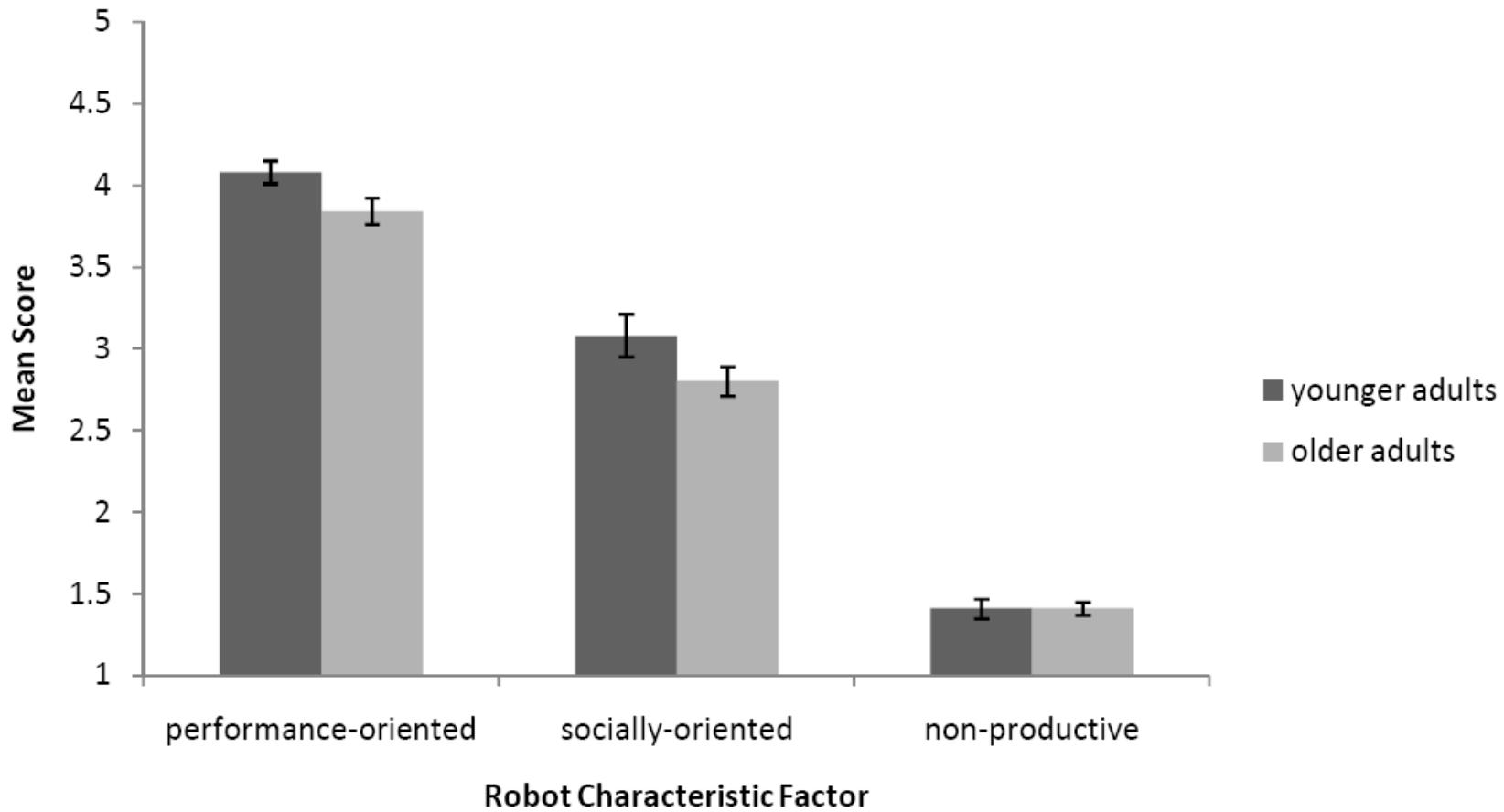
Figure 6. Participants' mean scores on the three robot characteristic factors. Error bars are standard errors of the mean.

1. Respondents considered performance characteristics more critical for the robot they imagined, followed by social features.
2. Age-related differences minimal once technology experience controlled.

Robot Roles

the robot replaces a human or acts like a human,

the robot plays more of a supportive role to the user

the robot would be considered subordinate to the user
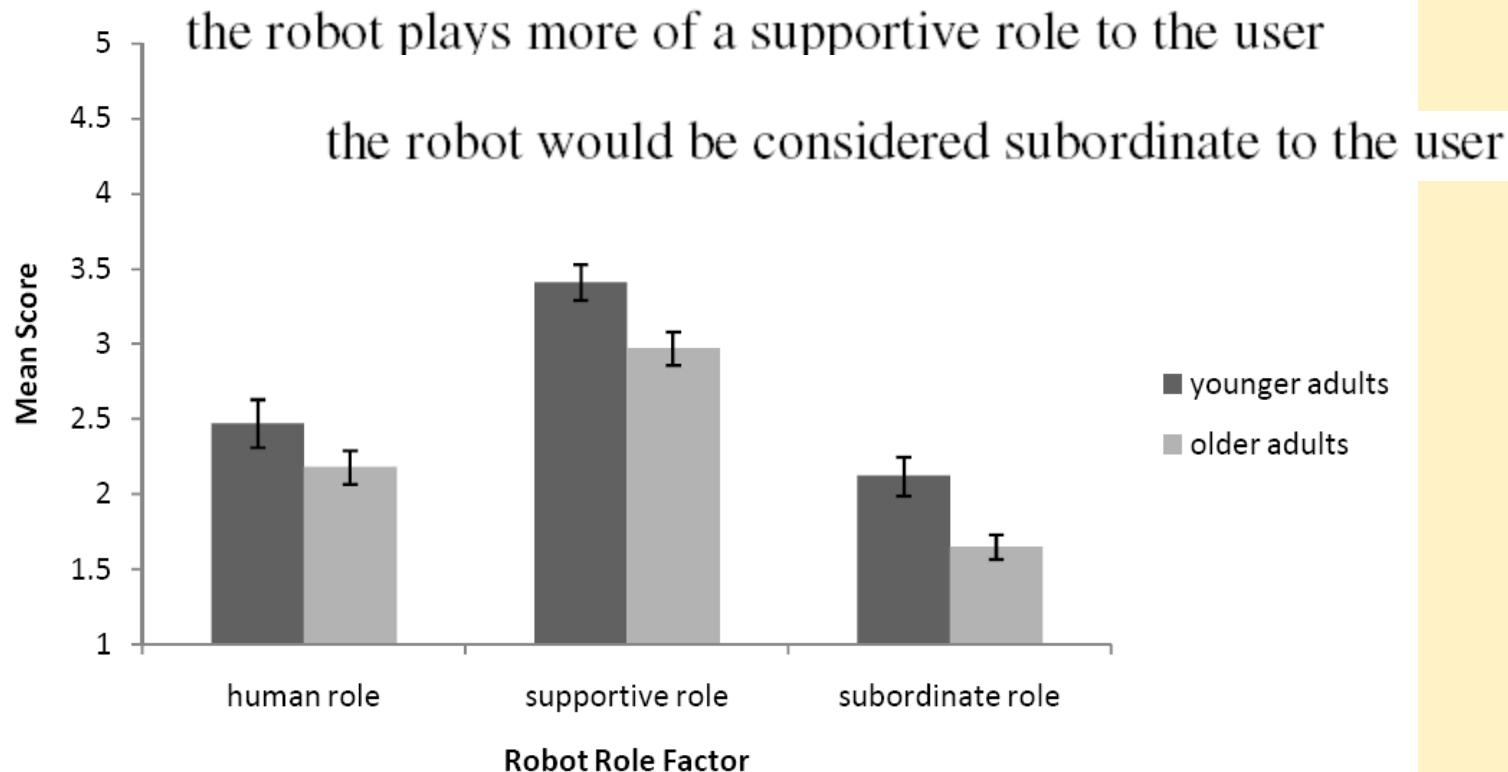
Figure 7. Mean scores of younger and older adults for the three robot role factors. Error bars are standard errors of the mean.

Overall – more focus on supportive role; however, older adults more moderate in the roles assigned.

Table 18. *Correlations between the Three Robot Characteristic Factors and the Three Robot Role Factors*

Factor	Human role	Supportive role	Subordinate role
1. Performance-oriented traits	.287**	.560**	-.089
2. Socially-oriented traits	.681**	.454**	-.064
3. Non-productive traits	-.231**	-.229**	.231**

**significant at the .01 level (two-tailed)

1. Human role: tend to think more about social than performance characteristics; not non-productive traits.

2. Supportive role: tend to think about performance and social traits; not non-productive traits.

3. Subordinate role: more concerns about non-productive traits.

Trust in Care-Giving Robot

"Imagine that something happened to you (e.g., broke a bone, got sick, lost your memory). If you had to choose between being moved to a care facility (e.g., nursing home, assisted living facility, rehabilitation facility) or remaining in your home and having to use a robot to assist you, which would you choose?"

	Remain Home with Robot	Move to Care Facility	Don't Know
Younger	67%	18%	15%
Older	70%	7%	23%
Combined	*69%*	*11%*	*20%*

Summary of Findings

- Openness to robots in home environment.
- Insights into semantic knowledge younger and older adults have about robots
  - Minimal age-related differences, once technology experience controlled.
  - Imagined robots have both human-like & machine-like characteristics.
  - Expectations of robot in the home mostly as helpful, purposeful devices.
  - Benefit of robot may be more important for acceptance than appearance & social ability.

As robots become more advanced, how should they interact and communicate with humans?

Georgia Tech Digital Lounge

Gaming | Digital Life | Entertainment & Music | Health & Education

HEALTH & EDUCATION

Is My Robot Happy to See Me?

Atlanta (October 19, 2009) —People are social creatures. Robots … not so much. When we think of robots, we think of cold, metallic computers without emotion. If science fiction has taught us anything, though, it's that we crave emotion, even in our robots - think C-3PO or Star Trek's Data. So it stands to reason that if robots are ever going to become a fixture in our society, even becoming integrated into our households, we need to be able to read their faces. But how good are we at reading robot faces?

Scientists at Georgia Tech decided to test our ability to interpret a robot's "emotion" by reading its expression to see if there were any differences between the ages. They found that older adults showed some unexpected differences in the way they read a robot's face from the way younger adults performed. The findings will be presented at the upcoming Human Factors and Ergonomics Society 53rd Annual Meeting, Grand Hyatt, San Antonio, Texas on Thursday, October 22.

Click on an image below to see the full photo
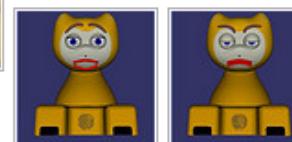
PHOTOS

Conclusion

- Aging-in-place
  - Multi-faceted problem
  - Solution success will depend on:
    - Understanding user capabilities, limitations, needs, preferences, and attitudes
    - Involve older adults in process of development and testing

Translating Research into Practice

- **wendy@gatech.edu**

- **www.awarehome.imtc.gatech.edu**
  - Aware Home Research Initiative

- **www.hfaging.org**
  - Human Factors and Aging Laboratory

- **www.create-center.org**
  - Center for Research and Education on Aging & Technology Enhancement

Human Factors & Aging Series

Designing for Older Adults

Principles and Creative Human Factors Approaches

Second Edition

Arthur D. Fisk
Wendy A. Rogers
Neil Charness
Sara J. Czaja
Joseph Sharit

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