# GERONTECHNOLOGY

Sensory Changes & Health

## Aging

- All parts of the body are affected by aging.
- What are some signs of aging?

## Sensory Systems

- All knowledge of the world comes to us through our sensory systems
- Sensation refers to the reception of information by the eyes. ears, skin, tongue, nostrils and other specialized sense organs.
- Sensation differs from perception or giving meaning to the information


## Sensory Systems

- Sensory changes begin in the 40s and 50s but don't appreciably limit behavior until about the 70s or 80s
- Keep in mind individual differences
  - Vision – mid 50s
  - Hearing – mid 40s
  - Touch – mid 50s
  - Taste – mid 60s
  - Smell - mid 70s
- Why should we care about changes in the sensory systems when designing technologies for older adults?

## Sensory Loss

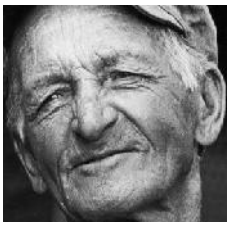
•Decreased ability to respond to stimuli that affect our senses (hearing, touch, etc.).
•It takes stronger stimuli for the aging person to obtain the quality and quantity of information from the environment needed for effective, adaptive action
- •lights need to be brighter
- •sounds louder
- •smells stronger

•Alterations in the environment and product design along with assistive technologies are necessary to help older adults compensate for sensory loss, enjoy products and maintain independence

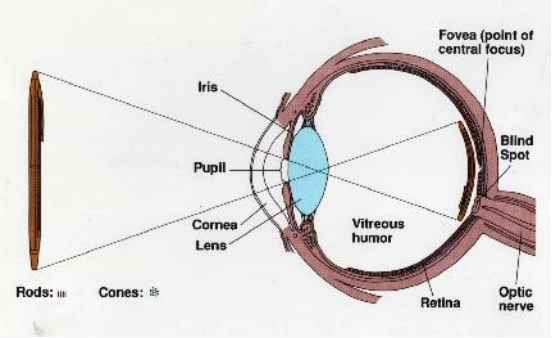
## Sensory Loss

•Wittich & Gagne (2017) chapter
- •Were you surprised by anything that you read in this chapter?
- •Did it make you think differently about technology development for the aging population?

# Vision

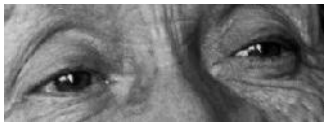


- Eye Structure Changes
  - Pupil becomes smaller
  - Lens becomes more yellow (brunescence) and less flexible
  - Field of vision shrinks
  - Iris loses pigmentation
  - Decreased blood circulation in retina




# Vision

- Everyday Effects of Eye Structure Changes
  - Less light reaches retina (pupil); lights need to be brighter; decreased ability to function in low light levels; reading
  - Decreased ability to adjust to changes in illumination & glare (pupil); increased safety risk in changing environmental light
  - Presbyopia (far-sightedness – decreased ability to focus on nearby objects); decreased ability to focus on objects at different distances(lens); reading food or medication labels; driving
  - Eye color fades (iris)



# Vision

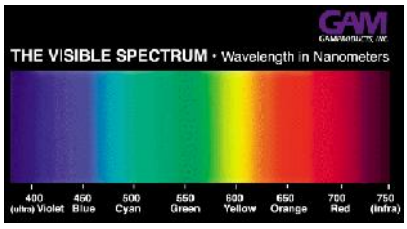
- Decline in visual acuity; takes more time to recognize objects; effects ability to detect details of objects; difficulty watching TV
- Snellen Chart

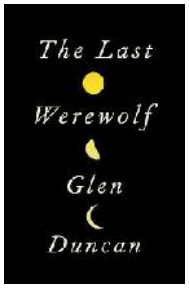
| Visual Acuity | Age 18-20 N=166 | Age 60-69 N=62 | Age 70-79 N=68 | Age 80+ N=18 |
|---|---|---|---|---|
| 20/20 | 64% | 23% | 3% | 0% |
| 20/30 | 33% | 39% | 37% | 11% |
| >20/40 | 3% | 38% | 60% | 79% |

- Visual fields become smaller; increased safety risk for driving & maneuvering in the environment

# Vision

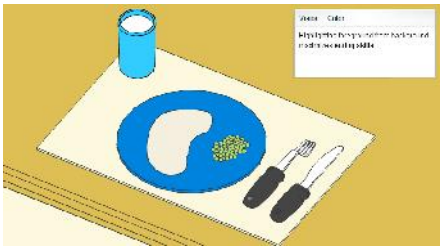
- Decline in color vision; world seen as yellower; greens, blues & purples harder to discriminate; closely related colors may be difficult or impossible to differentiate



# Vision

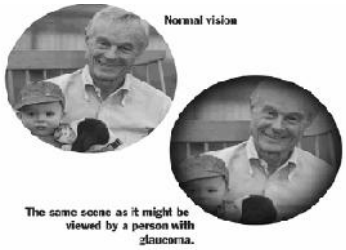
- To help compensate for age-related vision changes
  - Proper glasses for optimal vision
  - Increase light levels by using higher watt light bulbs (unless individual has an eye disease that makes them sensitive to light)
  - Evenly distribute to balance light sources to eliminate glare
  - Annual eye exam
  - Add contrasts to home environment



# Eye Disease in Elderly

- Cataracts (affect 70% of those 70+)
  - Lens becomes opaque & interferes w/ light passage
  - Results: blurred vision, glare in bright light, dull colors
- Glaucoma
  - Buildup of aqueous humor causing pressure within eyeball
  - Results: impaired peripheral vision, blurring, difficulty adjusting to light & dark, eye pain, blindness


Cataract Vision



## Eye Disease in Elderly

- Age-related Macular Degeneration
  - Destruction of nerve cells in the macula area of the retina
  - Results: decreased visual acuity in center of visual field, legal blindness
- Diabetic Retinopathy
  - Vessels in eye hemorrhage
  - Results: blurred vision, loss of eyesight


Macular Degeneration Vision


Diabetic Retinopathy Vision

## Visual Changes with Age

- Implications for Technological Design
  - Example: computer game development

# Useful Approaches for Teaching Older Adults with Visual Impairments

- Identifying yourself initially to get the learner's attention
- Facing the learners when speaking
- Using nonverbal cues and aids along with the verbal message
- Making sure eyeglasses, contact lens, or low vision aids are clean and used properly
- Using large print block typeface styles such as Gothic, Roman, or Bold with contrasting colors when using printed materials or audiovisuals
- Presenting one concept at a time
- Not standing in front of a window or mirror, both of which produce glare
- Not having the learner facing a glaring light source. Lights should preferably be adequate, glare-free, and located behind the individual to avoid reflection
- Making sure the learner is sitting near the presenter or the source of information
- Using tapes, CDs, large print newspapers, magazines, and books obtained from the State Division of Blind Services
- Obtaining a special radio from the radio reading service to hear selected programs
- Using a multiple sensory approach in teaching; keeping in mind that too much stimulation for some learners may result in stress and less learning

# Vision Assistance Technology

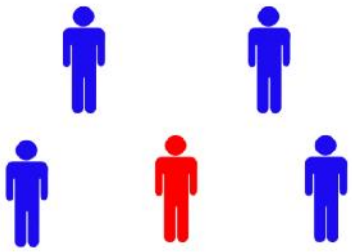
- Everyday Living
  - talking watches
  - large button phone
  - check writing guide
- Magnifiers
- Text to speech

tech4aging.wsu.edu

http://tech4aging.wsu.edu/vision-1.aspx

# Hearing Loss

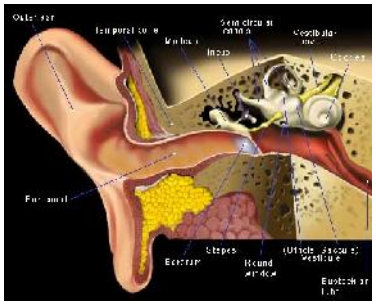
1 in 5 people over age 45 have hearing loss



1 in 2 people over age 75 have hearing loss

# Hearing

- Changes
  - Outer Ear: increased wax secretion may cause blockage of auditory canal
  - Middle Ear: ossicular bones become stiffer & less elastic
  - Inner Ear: degeneration of cochlea

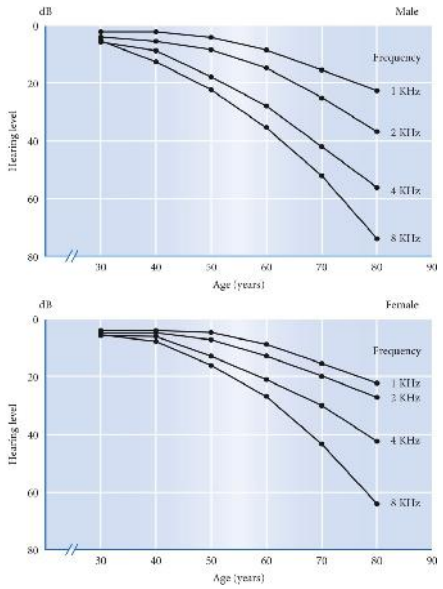


# Presbycusis: age-related hearing loss

- High-pitched voices become especially hard to understand

| | Age 18-28 N=166 | Age 60-69 N=62 | Age 70-79 N=68 | Age 80+ N=18 |
|---|---|---|---|---|
| 200 | 98% | 97% | 90% | 61% |
| 3000 | 98% | 89% | 59% | 28% |
| 5000 | 99% | 68% | 41% | 11% |

- High-pitched consonants (e.g., z, s, t, g, f, p, th, sh) become more difficult to distinguish
- Hearing Test: https://www.youtube.com/watch?v=9vqY7cJpwRs
- Background noises are more likely to interfere with hearing
- Everyday effects: problems hearing on telephone & in noisy places (e.g., restaurant) problems in understanding speech (e.g., missed directions), decreased quality of communication, social isolation, low self-esteem



## Hearing Disease in Elderly

- Conductive deafness
  - blockage/impairment of outer or middle ear so that sound waves do not travel properly
  - Results: muffled quality to sound, own voice sounds loud so often speak softly
- Sensorineural hearing loss
  - Damage to inner ear, the cochlea, or the auditory nerve
  - Result: hearing loss

## Hearing

- Implications of hearing loss for technological designs
  - Example: verbal prompting technology

- From Wittich & Gagne chapter (2017) … at a minimum when incorporating an acoustic signal in design make sure to account for:
  - Loss of audibility in high frequencies (> 3,000 Hz)
  - Poorer auditory intensity, frequency and duration discrimination abilities even where hearing is WNL
  - Poorer frequency and temporal resolution
  - Poorer sound localization

## Hearing

- To help compensate for age-related hearing changes
  - Use a hearing aid if needed
  - Use a microphone amplifier to enhance hearing when radio or TV set at a normal level
  - Try to cut down on background noise (e.g., turn off TV during conversations, ask for quiet sections in restaurants).
  - Annual hearing exam

## Hearing Assistance Technology

- Telephones
- Signal devices
- Amplifiers
- Audio playback
- Hearing Aids

http://tech4aging.wsu.edu/hearing-1.aspx

## Hearing Assistive Listening Devices

- Hearing aids are typically underused, why might this be?
- How might assistive listening devices be helpful?
- How might dual sensory impairments effect technology design?

## Useful Approaches for Teaching Older Adults with Hearing Impairments

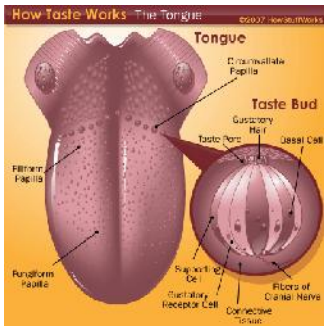
- Alerting the learner to your presence, facing him or her when speaking, and having adequate light in the teaching areas
- Speaking slowly and distinctly and lowering the pitch of your voice; do not shout or over-articulate
- Awareness of whether or not the learner's reactions indicate that you are being understood. Such reactions may include cupping the ear, a puzzled expression, turning the "good ear" toward the presenter, and consistently responding "yes" to questions
- Encouraging the learner to use his or her hearing aid and verifying that it has functioning batteries
- Using appropriate gestures and/or facial expressions to enhance speech
- Stimulating multiple senses through the use of visual material, audiory messages, and the use of touch and smell as appropriate
- Not clouding spoken messages by the use of background music or noise
- Repeating questions asked by class members so that everyone attending the class can understand
- Using a microphone when necessary
- Use gestures with hands, facial expressions & visual aids
- Stay still so that the person can see you and your lips
- Do not write on a blackboard and talk while your back is to the audience
- Repeat questions form the audience before answering the questions

# Taste, Smell and Aging

- To taste food you must have the sense of smell
- Changes in taste and smell can make eating less enjoyable
- If food seems to have very little flavor, it will be less appealing

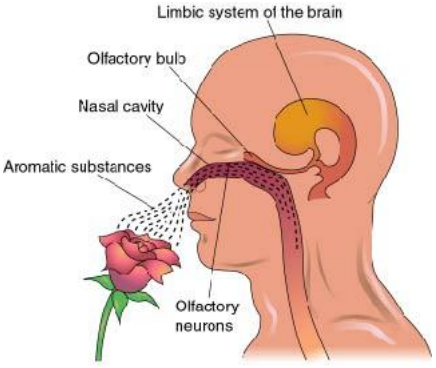
# Taste

- Changes in Taste (minimal)
  - Decreased taste buds (245 at age 30 on each papilla; 88 at age 70)
  - Decrease saliva
  - Result: decreased taste sensitivity, especially for sweet & salty tastes; food may taste less flavorful; loss of appetite?; decreased socialization



## Smell

- Changes in Smell (minimal)
  - Atrophy of neurons in olfactory bulb
  - Decreased sensitivity to smell; limits enjoyment of eating; reduces ability to identify spoiled food, smoke or gas leak; can contribute to malnutrition; not picking up on own body odor




## Aging and Changes in Taste & Smell

- Taste losses
  - disease states of nervous & endocrine systems
  - nutritional & upper respiratory conditions
  - viral infections
  - medications
- Olfactory losses in healthy adults
  - normal aging process
  - medications
  - viral infections
  - long-term exposure to toxic fumes
  - head trauma

# Touch and Aging

- Decreased number of sensory receptors for each somesthetic sense
- Inability to correctly detect stimulation from the environment; reduced reaction time, susceptibility to falls; problems differentiating coins; problems picking up small objects

| | | |
|---|---|---|
| Sensation | Decreased vibratory sense | Increases risk for injury |
| | Decreased two-point discrimination | Decreased ability to sense pressure |
| | Decreased temperature sensitivity | Decreased protective response to withdraw from hot objects |
| | Decreased balance | Risk of falls |
| | Decreased Proprioception | Risk of falls |
| | Changed pain sensation | Decreased protective mechanism |

*Source*: Adapted from Bromley, 2000 [Level VI]; Linton, 2007 [Level V]; Murphy et al., 2002 [Level III]; Schiffman, 1997 [Level V]; Seilberling & Conley, 2004 [Level V]; Wallhagen et al., 2006 [Level VI]; Whiteside et al., 2006 [Level V].

# Touch

- Skin becomes less elastic with age and loss of temperature sensitivity may decrease response to pain until skin is damaged
- May not notice cut, blister or other injury that can lead to infection
- Fire, Burn and Scald Prevention
  - Lower electric water heaters to 120 degrees F or to the LOW setting for a gas water heater (apartment dwellers can use an anti-scald valve)
  - When cooking use short or tight sleeves
  - Use large numerical timer with a loud alarm

## Aging and Changes in Touch

- Common disorders affecting tactile information
  - Cerebrovascular accident (CVA)
  - Peripheral vascular disease
  - Diabetic neuropathy
  - Peripheral neuropathy

## Useful Approaches for Teaching Older Adults with Taste, Smell, or Touch Losses

- In dietary teaching, especially regarding restricted diets such as low salt or sugar, being aware that decreased salt receptors may actually cause food to taste bland and individuals may the use more salt or sugar than usual
- Encouraging the use of spices, vinegar, herbs, and lemon to enhance salt-rstricted diets
- Being aware that safety may be compromised when the individual is unaware of the presence of smoke, gas, or spoiled food
- Encouraging the use of easily handled devices when teaching manipulative skills such as checking blood sugar levels or giving one's self an injection

## Barros, Leitao & Ribeiro (2014)

- Iterative design development for a mobile user interface for older adults
- What were some of the recommendations to come out of their work for design?
- Were there any recommendations that you were particularly surprised about?

## Barros, Leitao & Ribeiro (2014)

- Navigation
  - Be cautious about use of Panorama and pivot controls
  - Use the home screen menu as a safe point of return
  - Use the back button as a safeguard for older adults
  - Take advantage of scrolling if the application requires it
  - The use of the keyboard should be minimized
  - Use wordings that suit older adults' semantic field
- Visual Design
  - Provide generous spacing between items
  - Use icons along with text when designating buttons
  - Be cautious about the positioning of interactive elements towards the edge of the screen

# Participant Demographics

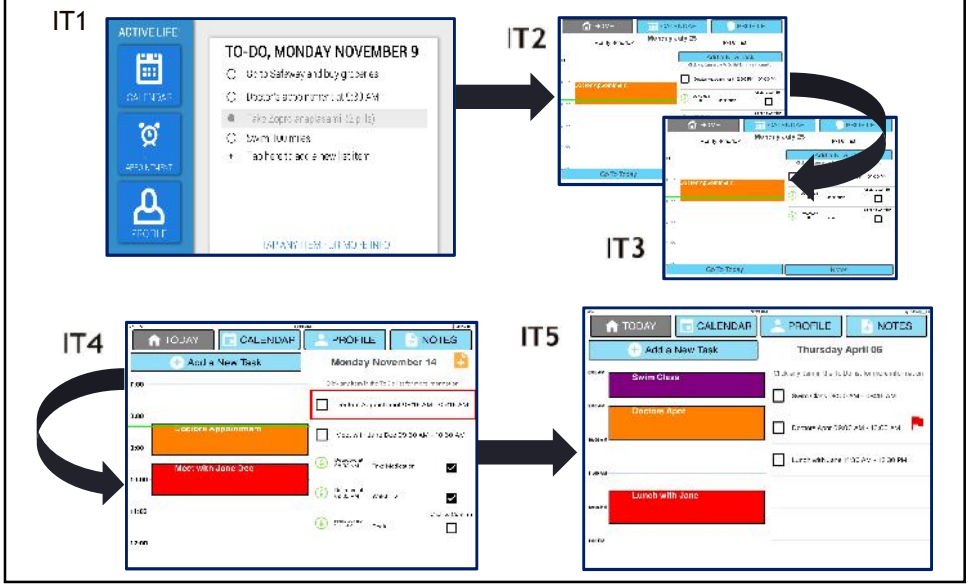
| | Iteration 1 | Iteration 2 | Iteration 3 | Iteration 4 | Iteration 5 |
|---|---|---|---|---|---|
| **Number of Participants** | N=8 | N=4 | N=5 | N=5 | N=5 |
| **Mean Age in years** | 71.25 | 72.25 | 71.40 | 69.2 | 72.8 |
| **Age Range in years** | 46-94 | 62-94 | 67-77 | 54-88 | 67-77 |
| **Description** | 1 Caregiver<br>7 Healthy Older Adults | 2 TBI<br>1 MCI<br>1 Caregiver | 2 Caregivers<br>3 MCI | 3 TBI<br>2 MCI | 5 MCI |
| **Gender** | 5 female<br>3 male | 3 female<br>1 male | 4 female<br>1 male | 3 female<br>2 male | 3 female<br>2 male |
| **Education range in number of years** | 13-20 | All 20 | 14-18 | 13-20 | 14-20 |

**Note: TBI = traumatic brain injury; MCI = mild cognitive impairment**

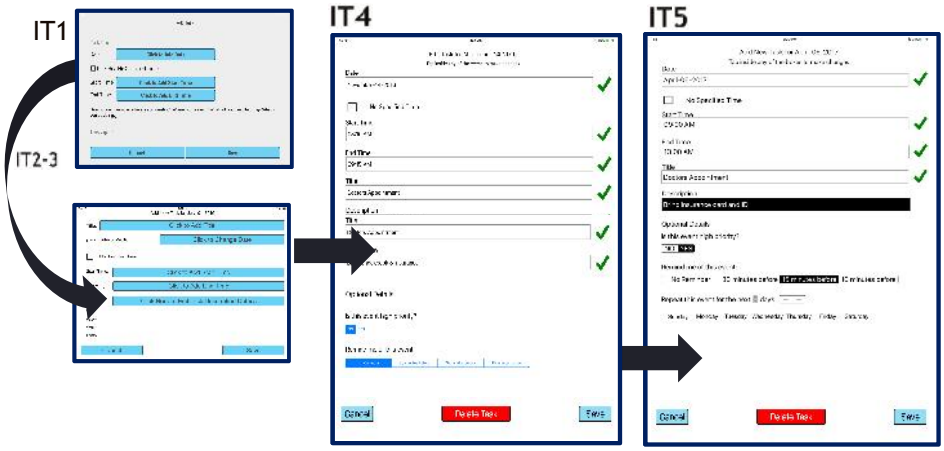
# Methods

- Each iteration of participants presented with 6-8 scenarios to complete
  - *"Imagine you have a doctors appointment on December 15th… Add to your To-Do List"*
- After Scenario Questionnaire
  - ease of use, time for task completion, and available support information
- Questionnaire for User Interface Satisfaction
- Open ended questions
  - *"Is there anything you would like to see in the app that was not shown to you today?"*
- Use feedback to improve design

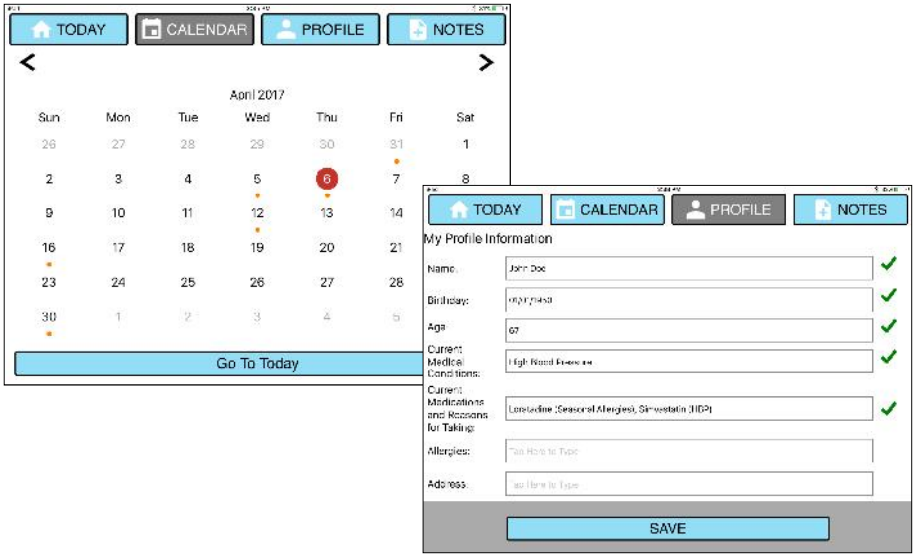
# Iterative Design of the Homepage




# Iterative Design of the Add New Task

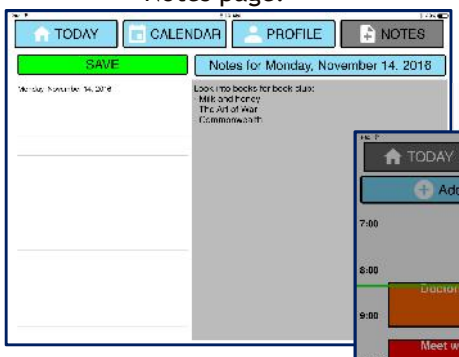


# Calendar and Profile Pages

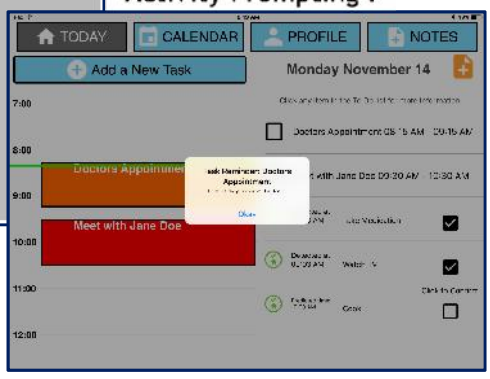



# Additional Features in Iteration 4-5

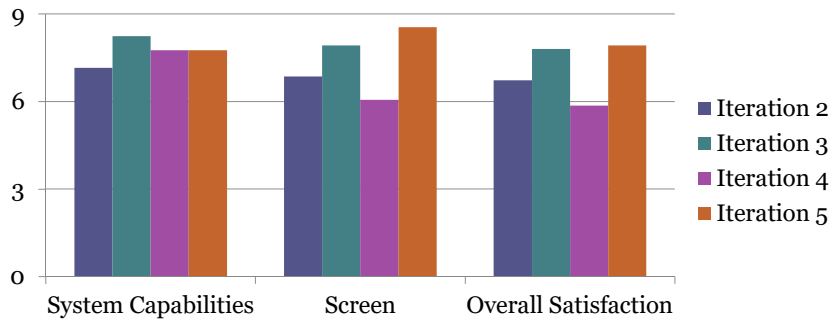
Notes page:




Activity Prompting :



# Expect Variability: Users Differ




**Scale from 0 = Worst Attribute (i.e. "Terrible') – 9 = Best Attribute (i.e. "Wonderful")**

# Lessons Learned

- Test technology in the settings where users will be using them
- Work with the types of users that will be using the technology
- Be ready to consider other methods for understanding the users experience when engaging individuals with cognitive impairment
- Be prepared for variability in responses

## Good Design may not be Enough

- Other barriers to adoption
  - Costs
  - Loss of privacy
  - Lack of insurance coverage
  - Lack of support and training for users, caregivers and health care professionals
  - Social influence
  - Stigma or image
  - Self-efficacy