

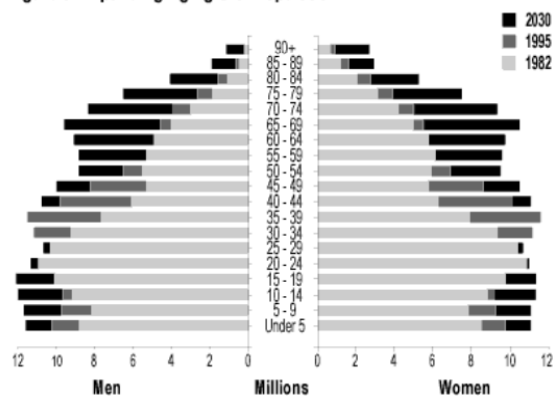
6.S196 / PPAT: Principles and Practice of Assistive Technology

Today: Functional Deficits
that Accompany Aging

Monday, 7 November 2011
Prof. Seth Teller

Demographics of Aging

Figure 3. Expanding Aging U.S. Population



Source: U.S. Census Bureau, Population Projections of the United States by Age, Race, and Hispanic Origin: 1993-2050, P25-1104, 1993

Changes Associated with Aging

- Physical
 - Skin, hair, height, weight, speed, strength
 - Decreased night vision, lung capacity, gait speed
- Sensory/perceptual
 - Hearing, vision, touch, proprioceptive, kinesthetic
- Cognitive
 - Memory, speed, dementia, psychological
- Social
 - Reduced participation, increased dependence

Sensory/Perceptual Function

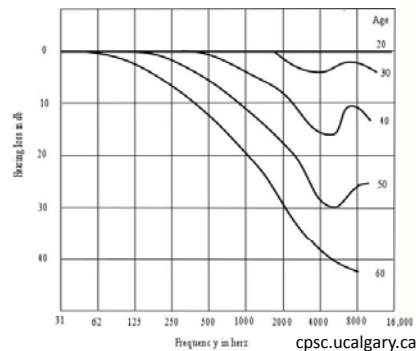
- Hearing
- Vision
- Taste
- Smell
- Touch
- Proprioception
- Kinesthetic sense

Hearing Impairment

- Common causes
 - Deterioration of inner ear mechanisms
 - Persistent/traumatic exposure to loud noises
 - Some medications (e.g. painkillers, antibiotics)
 - Insufficient nutrients in diet
 - Genetic factors

Manifestations

- Loss of response at high frequencies
 - Typically ~40 dB at 8 KHz by age 60



- Distortion hinders speech understanding
 - Especially on telephone, or out of line of sight

Technological/contextual aids

- Hearing aid / cochlear implant
 - Differential frequency response, amplification
 - Signal processing for frequency compression
- Accommodation by speech partners
 - Speak with greater volume (without shouting)
 - Effort to use a lower pitch when speaking
 - Clearer articulation of speech sounds
 - Speaking from within field of listener's vision
 - Slower speech, enabling listener to grasp intent

Vision Impairment

- Common causes
 - Age-related macular degeneration
 - Cataracts
 - Diabetic retinopathy
 - Glaucoma

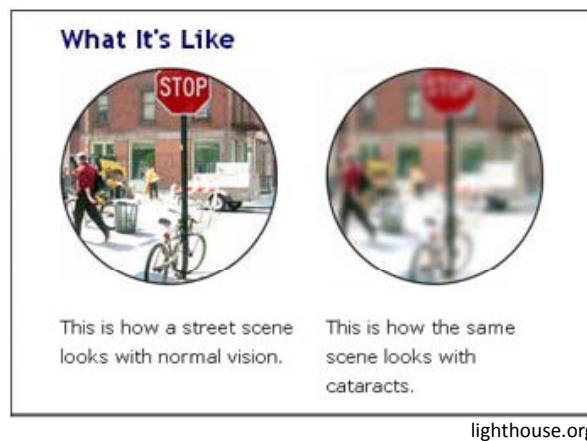
Age-Related Macular Degeneration

- Loss of light-sensitive cells in macula



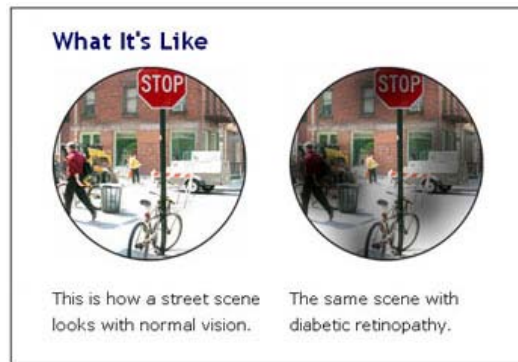
Cataracts

- Clouding of lens of one or both eyes



Diabetic Retinopathy

- Complication of diabetes (insufficient regulation of blood insulin, glucose)
 - Interference with functional tissues of retina



Glaucoma

- Excessive fluid pressure damages optic nerve
 - Blur, halos, blank spots, loss of peripheral vision



- Symptoms develop gradually, can be hard to notice

Technological/contextual aids

- AT devices for low vision
 - Lighting, magnification, contrast enhancement
 - Optical character recognition, speech synthesis
- Retinal / occipital cortex implants
 - Still in experimental stage
- Facilitation by partners/caregivers
 - Awareness of functional regions of visual field
 - Awareness of visual system effective resolution
 - Arrange lighting, presentation to suit abilities
 - Accompaniment by audible/tactile stimuli

Mobility and Manipulation

- Deficits in proprioception
 - Problems with balance, dizziness
 - Slower reaction times, less effective reflexes
 - Gait abnormalities, increased fall risk
- Deficits in fine manipulation
 - Higher thresholds for touch, pain sensitivity
 - Slower nerve conduction speeds, less dexterity
- Declining strength and endurance
 - Implications for physically demanding tasks

Top Fall Risks (Anderson, 2004)

Main accidental cause of death for those 65+ !
(Increases in winter due to ice/darkness, but most falls are indoors.)

- 1) Stairs (especially those without handrails)
- 2) Footwear providing poor traction
- 3) Standing on chairs or other objects to reach
- 4) Furniture that obstructs path
- 5) Throw rugs that slip when walked upon
- 6) Narrow and/or twisting passages
- 7) Non-furniture obstacles (cords, clothes, shoes, clutter)
- 8) Dim or insufficient lighting
- 9) Lack of traction strips in bathtub/shower

Anderson, Fear of falling: senior citizens face serious injury, death from losing their balance. Atlanta Journal-Constitution, 6 Jan 2004.

Mitigating Fall Risks (Enix et al. 2011)

Orthostatic hypotension	Rise slowly after sitting
Postprandial hypotension	Evaluate carbohydrate intake
Low back pain	Chiropractic care/physical therapy
Muscle weakness	Exercise, tai chi, yoga, walking
Balance problems	Fall exam, walker, 3-point cane
Transferring to bed, toilet, couch	Lower bed/raise toilet, add railings
Lighting, clutter, stairs, slippers	Home inspection/Occupational therapy
Medication increased fall risk	Review medications, like psychotropics
Fear falls/loss of independence	Medic-Alert pendant/bracelet

Enix et al., Balance Problems in the Geriatric Patient,
Topics in Integrative Health Care 2011, Vol. 2(1)

CDC, Injury Prevention & Control: Home and Recreational Safety
<http://www.cdc.gov/homeandrecreational/safety/falls/index.html>

Cognitive Deficits

- Impaired senses of hearing, vision, touch
- Vulnerability to poor aural/visual conditions
- Slower reaction/response times
- Declines in sustained attention
- Less effective working memory, recall
- Difficulty with multi-tasking
- Difficulty learning new routines
- Difficulty identifying salient information

Dementia

- Majority of cases due to Alzheimer's disease
 - Plaques and tangles in neural tissue
 - About 6-8% of those over 65 affected
 - More than 30% of those over 85 affected
- Symptoms
 - Wandering/getting lost, memory loss, poor personal hygiene, failure to take meds
 - However many with dementia can orient to place, person and time into advanced stages

Personal/Societal Costs

- Decreased quality of life
 - Loss of independence in activities of daily living
 - Loss of privacy (family, outside caregivers)
- Associated costs (est. \$100B annually in US)
 - Family caregivers: lost wages, opportunities
 - Non-family caregivers: wages
- Implications when receiving medical care
 - Difficulty giving medical history information
 - Difficulty following medical recommendations

Technological/contextual aids

- Medical (some reversible/treatable causes)
 - Thyroid; B12 deficit; sensory deficit; depression
- Wander detection / navigation aids
 - Alert to caregivers (e.g. MIT system at TBH)
 - Prompted/unprompted guidance “home”
- Cognitive aids for sequencing tasks
 - Daily routines, medical regimens, etc.
 - Independent validation is challenging

AT Perspective

- Aging tends to bring a mix of impairments
 - Sensory, motor, cognitive, psychosocial
- Variety of mitigating strategies
 - Contextual: lighting, physical modifications
 - Technical: hearing aids, vision enhancements
 - Caregiver: prompting, assistance with ADLs
- Ripe area for development of novel AT
 - Use of machine sensing, mobility, manipulation
 - Very challenging: safety, abandonment, social
- Pressing problem: demographics to 2100

Coming Up

- Today (Monday) in lab:
 - Check-ins with each team
- Wednesday lecture:
 - Prof. Krzysztof Gajos
- Wednesday lab:
 - Assistive technologies for efficient text input