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

Today: The Human User (I) [C&H Ch. 3]

Monday, 1 Oct. 2012
Prof. Seth Teller

Activity-Limiting Disabilities

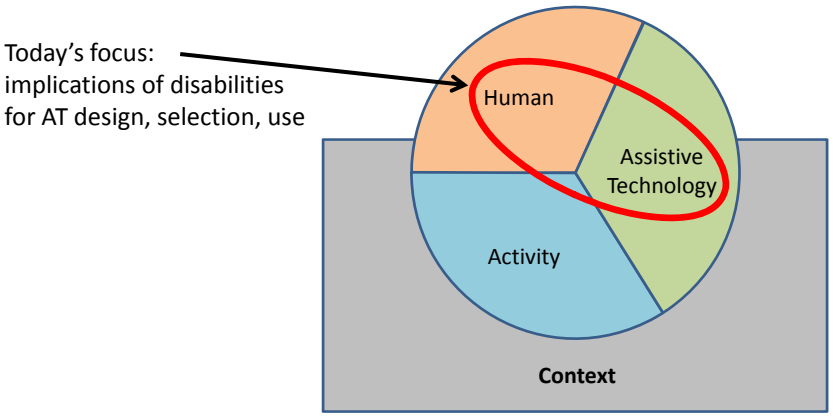
- Widespread
  - Tens of millions of Americans have a limitation that affects a major life activity (e.g. working, attending school, managing a household)
- Unevenly distributed
  - Disproportionately affect minorities, elderly, and those with lower socioeconomic status
- Expensive
  - Disability-related costs exceed hundreds of billions of dollars annually in the U.S. alone

Today

- Introduction of "Information processing model" of a human user with a disability
- Consideration of how disabilities affect human performance model
- Implications of disabilities for design, selection and use of assistive technologies

Review: HAAT Model

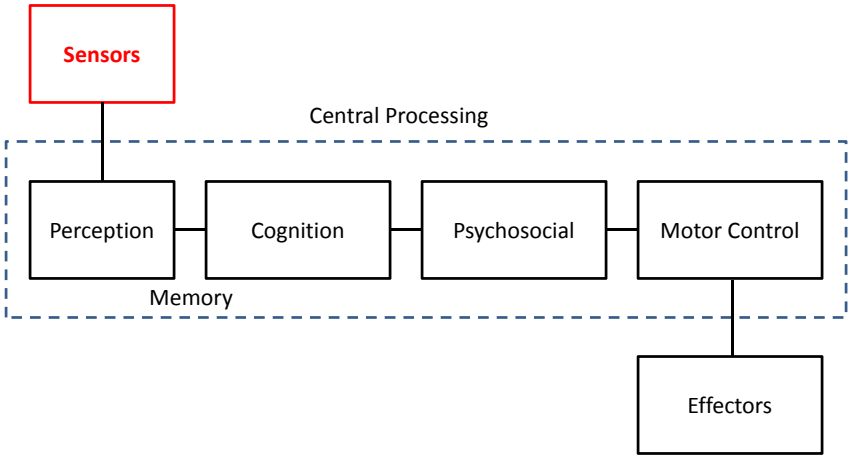
- Someone doing something, somewhere, involving the use of an assistive technology



Strategy for AT System Designer

- Focus on remaining (not on lost) function
- Determine what user can do (skills)
  … what user cannot do (limitations)
  … and what user will do (motivation)
- *Intrinsic enablers* of human performance:
  - Sensors
  - Central processing
  - Effectors
- Elements of *information processing model*

Information Processing Model



Terminology

- Proprioceptive sense
  - Relation of body parts, strength of effort
- Exteroceptive sense
  - Sensation of the world external to the body
- Interoceptive sense
  - Sensation of pain, hunger, movement of organs
- Kinesthetic sense
  - Sensation of motion of the body parts
- Vestibular sense
  - Sensation of balance and spatial orientation

Sensory Function and AT Use

- Obtain data from environment
  - Exteroceptive systems
  - Visual, auditory, tactile sensory systems
  - Levels of light, sound, mechanical pressure
- Obtain data from body
  - Proprioceptive, kinesthetic, vestibular systems
  - Body motion, limb motion, head orientation
- Limitations:
  - Sensitivity (minimum detectable levels)
  - Range (variation in size, amplitude, magnitude)

Visual Function

- Visual scanning
  - Finding a target in a field of several targets
- Visual tracking
  - Following during target or head/body motion
- Visual acuity
  - Distinguishing a small or low-contrast target
- Visual range
  - Visual attention as the target location (in the visual field) or depth (in the scene) varies

Capabilities and Deficits

- Visual acuity
  - Object size, color, contrast; inter-object spacing
  - Inability to detect/distinguish items, background
- Visual field and range
  - Ordinary range > 165^{o} to either side of midline
  - Loss in visual field(s), achievable range of gaze
- Tracking, scanning, vergence, accommodation
  - Focus on target as it moves laterally or in depth
  - Inability to stabilize, transfer gaze to new target
- Implications for AT design, use?

Auditory Function

- Auditory thresholds
  - Audible sound *amplitude* (dB w.r.t. reference)
  - Audible sound *frequency* (Hz)
- Deficits in degree and type of hearing loss
  - Loss of input information (from environment)
  - Loss of feedback (from user's own speech)
- Important in consideration of *context*
  - Use in a quiet vs. loud environment
  - Power, form factor considerations
- Other implications for AT design, use?

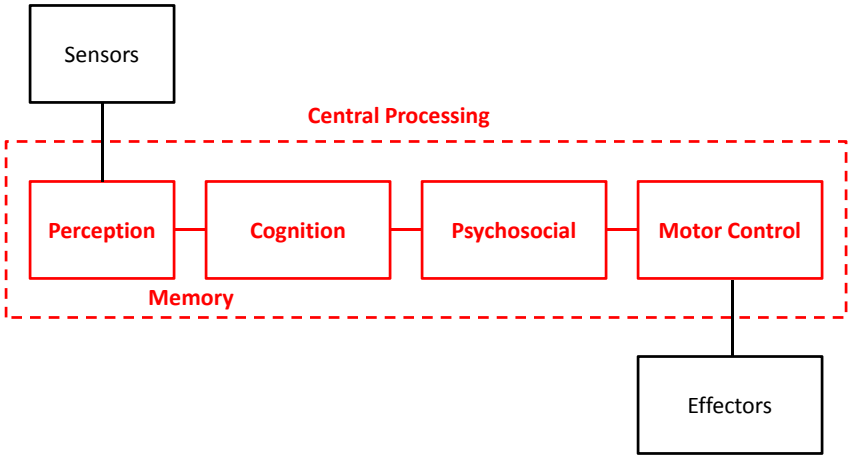
Somatosensory Function

- "Where body ends and the world begins"
- Peripheral sense, feedback to motor system
  - Pressure
  - Hot-cold
  - Tactile
  - Kinesthetic
- Deficits can result in tissue damage
  - Especially important for seating/cushion systems
- Other implications for AT design, use?

Sensing for Posture and Position

- Posture and body position control are fundamental to effective use of AT
  - To support tracking, reaching, selection etc.
- Accommodation to gravity, movement
- Integrative function of visual, vestibular, proprioceptive, and kinesthetic senses
- Impairment can hinder integration (e.g., mismatch of visual, vestibular data)
  - Sometimes correctable by prismatic lenses

Information Processing Model



Central Processing Functions

- Interposed between sensors and effectors
- Include:
  - Perception
  - Cognition
  - Psychological factors
  - Neuromuscular control & motor planning
- To be covered in a future lecture

Summary

- Emphasis on human user (AT "operator")
  - Information processing model
- Components underlying performance
  - Sensory, perceptual, cognitive, psychosocial, motor, effector movement characterization
- Implications for AT design, selection, use