

6.811 / PPAT: Principles and Practice of Assistive Technology

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

Wednesday, 11 Sep. 2013
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Activity-Limiting Disabilities

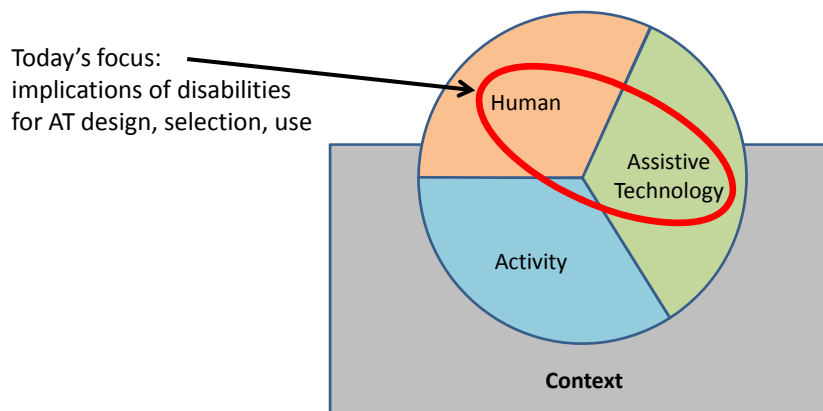
- **Widespread**
 - Tens of millions of Americans have a limitation that affects a major life activity (e.g. working, attending school, managing a household)
- **Unevenly distributed**
 - Disproportionately affect minorities, elderly, and those with lower socioeconomic status
- **Expensive**
 - Disability-related 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

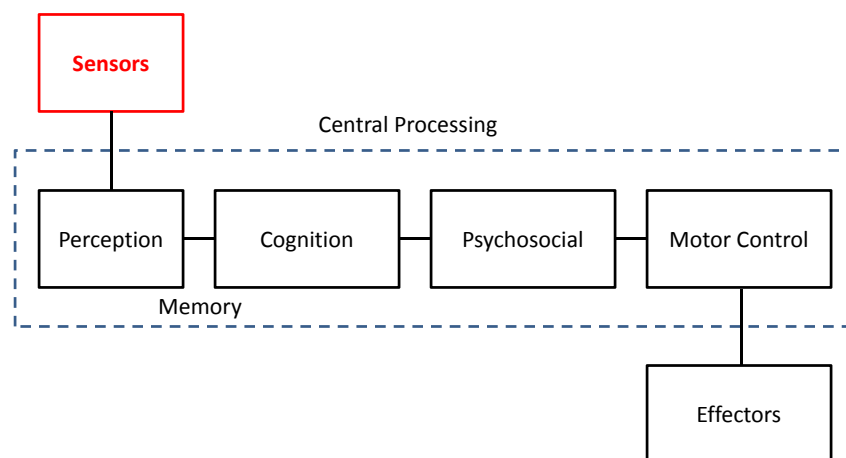
- Someone doing something, somewhere, involving the use of an assistive technology



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 $> 165^{\circ}$ 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

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

Coming Up

- This afternoon’s lab
 - Discussion of wheeled mobility lab
- Monday lecture
 - Ethics (Prof. Miller)
- Monday lab
 - Human subject protection
- Wednesday lecture
 - Information processing model (continued)
- Wednesday lab
 - Voiceover / screenreaders