Technologies to Support Independence Across the Continuum of Prevention for Cognitive Aging

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Technologies to Support Independence

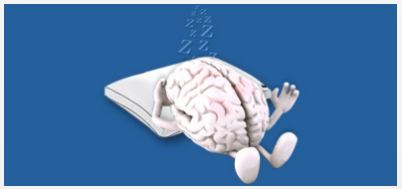
- How can we design technologies at all stages of prevention to reduce and delay impact of cognitive aging and dementia on everyday functioning?

Why is this important?

- Functional impairment in older adults has been associated with numerous negative health care consequences
  - Increased health care utilization
  - Placement in long-term care facilities
  - Number of days in the hospital
  - Falls
  - Loss of self-esteem
  - Poorer quality of life (also for caregiver)
  - Conversion to dementia
  - Morbidity and mortality

Primary Prevention: Support Brain Health

- Exercise
- Cognitive Engagement
- Social Engagement
- Good Eating Habits
- Good Sleep Hygiene
- Stress Reduction



Technologies to Support Brain Health

- Wearable systems for tracking mobility and other health related activities
  - Fitbit, phone apps, Pulse O2 activity, sleep & heart rate tracker
- Social networking technologies
  - E-mail, internet, Skype
- Intelligent systems that can learn and monitor behaviors and prompt to assist in increasing better health related behaviors (e.g., food management, mental exercise, physical exercise)
  - Smart homes
  - Wearable technologies
  - Smart homes partnered with wearable technologies

Challenges

- How can technologies be used/designed to:

(a) engage individuals in healthy behaviors
(b) motivate continued engagement in behavic
that support brain health

  - gamification; changing reward structures; social competitions

- How can the use of technologies for brain health be introduced into people's everyday lives at an early age?
  - Create perception of promoting successful life span development rather than center on disability and pathology
  - Make brain health technology fun to use, a status symbol

Secondary Prevention: Detect Early Cognitive Changes

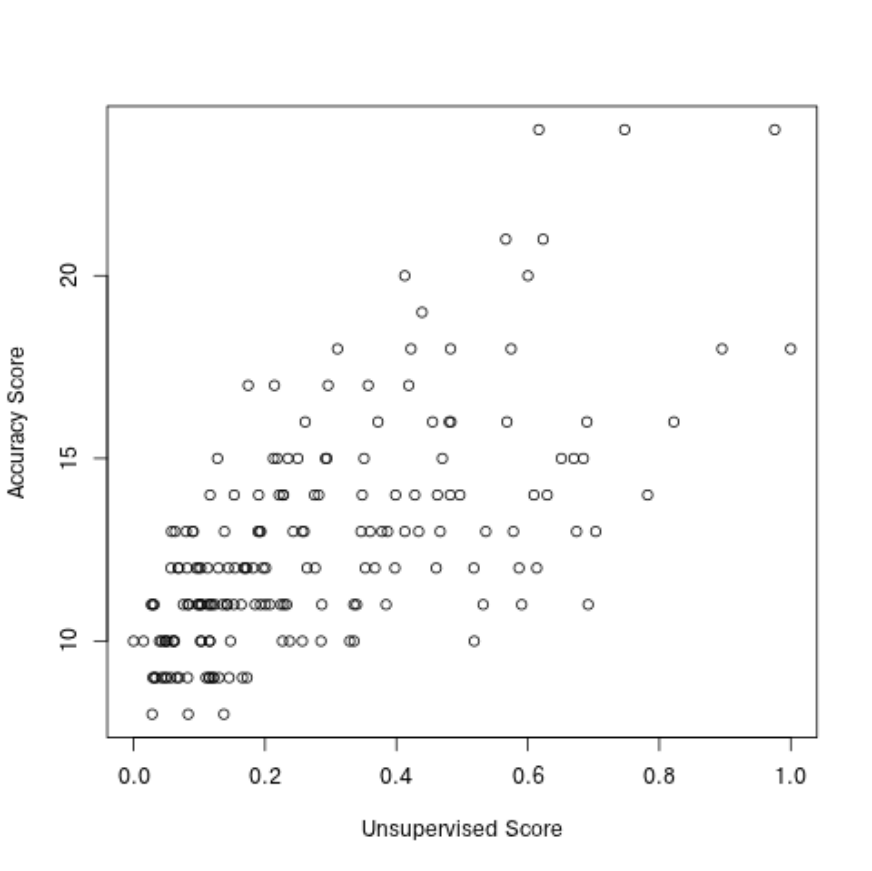
- Allows individual to be more proactive in their health care
- Important to introduce non-passive technologies early to encourage familiarity and development of automatic habits before cognitive skills become too impaired

Secondary Prevention: Detect Early Cognitive Changes

- Intelligent systems that continuously monitor behaviors and detect changes that suggest deviations in a person's health – both acute and gradual
  - Wearable technologies
    - Health monitoring apps, wireless sensing technology
  - Technologies embedded in real world
    - Computer use & game tracking, voice monitoring, EMA measures of mood, activity level etc.
  - Smart Homes
    - Assess functional status from sensor data (Dawadi et al., 2013)
    - Detect and predict functional change from sensor data: variability in daily activities, change in walking speed (Hayes et al., 2008)
- Reminder Systems
  - Annual checkup reminders; telehealth; automated pill boxes; call-centers; Google glasses, intelligent prompting technologies

Can we conduct functional assessment?

Data from Day Out Task



Day Out Task

Complete 8 tasks in preparation for a day out. Can multitask and interweave to complete the tasks in and efficient and natural way.

	Feature Type
DOT features	Duration, sensor counts, sensor events
Interruption features	Number of activity interruptions
Sequencing features	Sequence vector
Parallelism feature	Pindex

Dawadi, P., Cook, D., & Schmitter-Edgecombe, M. (2013). Automated cognitive health assessment using smart home monitoring of complex tasks. *IEEE Transactions on Human-Machine Systems.*

Challenges

- Continuous monitoring results in large amounts of data to be stored and interpreted
- Creating algorithms that will detect low base-rate events from sensor data
- Creating algorithms that will avoid high false positive rates
- Validating algorithms: demonstrating reliability and validity
- Preventing information overload for users
  - Determining most important aspects of data and best ways to present/visualize
- Reliability and longevity of sensors
- Encouraging early device use to promote habit

Tertiary Prevention for Cognitive Impairment

- Technologies can be used to complement formal human care
- Such technologies should:
  - Provide increase sense of safety & independence
  - Increase confidence in performing everyday activities
  - Allow adults to feel more active in their care
  - Have a positive impact on quality of life
  - Decrease feelings of isolation, improve communication with loved ones and improve social support
  - Be useful in energy and time conservation
  - Decrease feeling of imposition on family/friends
  - Decrease caregiver burden/stress
  - Be cost effective

Tertiary Prevention: Enhance quality of life for persons with dementia

- Promote safety
  - Night lights, flood detectors, outlet switch off devices

- Foster social communication
  - Picture button phones

- Act as a memory enhancer
  - Reminder watches, electronic calendars, item locators, pill box reminders, autographer for camera;

- Support daily activities
  - Motion sensor facets, bidets, intelligent prompting technologies

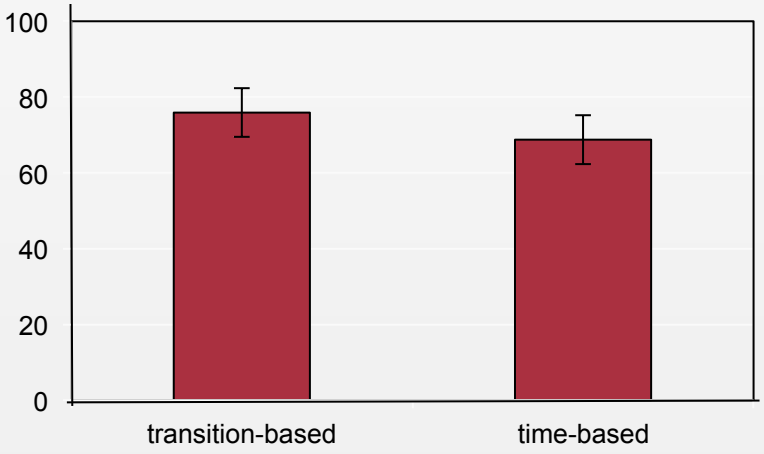
Tertiary Prevention – Intelligent Prompting Technologies

- At this stage, due to cognitive compromise a prompting device
  - Should not require user to provide feedback
  - Should alert individual to prompt
- To be most effective at this stage
  - Need context-aware prompting devices
  - Prompt during activity transition to avoid interrupting another activity
- Need to consider best way to deliver prompts and delivery device
  - Cueing hierarchy; verbal prompt versus multimodal
- What would need to be sensed to deliver appropriate prompts
  - Orientation of objects, safety devices use (e.g., walkers)

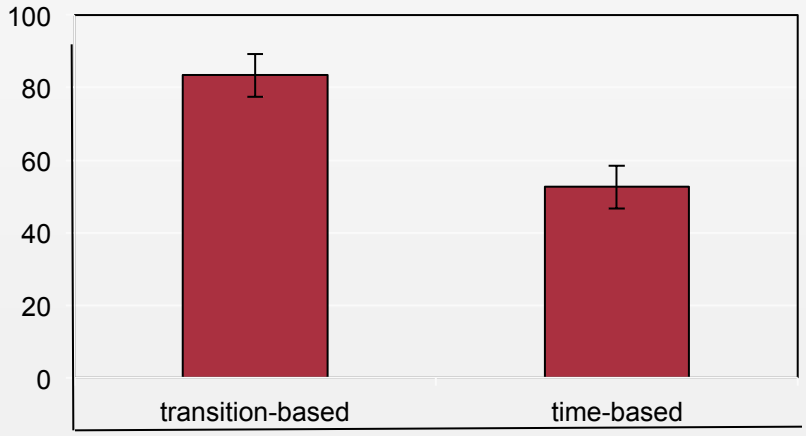
When is the best time to prompt? transition-based prompting

- Objective: To determine whether prompting during activity transitions increases compliance
- Participants: 42 undergraduate students
- Conditions:
  - Transition-based prompting
  - Time-based prompting

Percentage Time Wrote in Notebook



Percentage of First Prompts that Participants Acted on



Robertson, K., Rosasco, C., Feuz, K., Schmitter-Edgecombe, M., & Cook, D. (submitted). Prompting technologies: a comparison of time-based and context-aware transition-based promoting.

Can we develop prompting technologies? What types of prompts work best?

Cued Activities
Change a Light Bulb
Fold and Sort Laundry
Operate Telephone
Cook Oatmeal
Sort and Organize Bills
Wash Hands
Wash Countertops
Set up a Card Game

- **Cue types**
- Indirect
- Direct
- Multimodal

Activity	Description	Steps
Household chore: Change light bulb	Change a light bulb making sure to select the correct wattage light bulb from the storage drawer.	1. Checks lamp to determine correct wattage 2. Enters kitchen, retrieves correct box of light bulbs from cupboard "B", and brings box (or bulb) to dining room table 3. Unscrews old light bulb and takes it out of the lamp. 4. Screws new light bulb into the lamp 5. Throws away old light bulb 6. Returns box of light bulbs to supply closet in kitchen

Seelye, A. M., Schmitter-Edgecombe, M., Cook, D. J., & Crandall, A. (2013). Naturalistic assessment of everyday activities and prompting technologies in mild cognitive impairment. *Journal of the International Neuropsychological Society, 19,* 442-452

Tertiary Prevention: Enhance quality of life for caregiver

- Provide emotional support and information
  - Chat rooms, internet & telephone-based support groups, vidoconferencing
- Decrease worry and burden
  - Tracking technologies (GPS), floor mats, video monitors, door alarms, object finders
- Decrease additional stressors
  - Tele-care technologies

Challenges

- Designing intelligent context-aware prompting technologies
- Designing technologies that are passive - no or minimal user initiation or maintenance
- Designing technologies that require no new learning of user and that have the ability to learn about user and adjust to changing needs
- Making technologies acceptable to the end user
  - those with and without cognitive impairment may have different views about what is important or a particular technology
- Designing technologies that are low in cost and protect privacy

Other Challenges

- Lack of awareness and knowledge about technologies among professionals, users and caregivers www.tech4aging.wsu.edu (video series)
- Need for a managed database of available devices (e.g., LeadingAge CAST)
- Access to technologies and the training/support to use them efficiently
- Partnering between different technologies
- Attitudes towards devices and self-efficacy