
Note: This document is a reading guide of Chapter 3 of Gerotechnology, Research and Practice in Technology and Aging, edited by David C. Burdick and Sunkyo Kwon, Springer Publishing Company, 2004. This material is be used strictly for teaching and learning purposes.

Chapter 3. Designing technology based on cognitive aging principles

While the potential for improving the quality of older adults’ lives with technology is great, this potential may remain unrealized unless manufacturers and designers adhere to a user-centered approach to technology development. User-centered approach focus on the needs, capabilities, and limitations of the people who will be using these devices.

Cognitive changes that occur with age may influence task performance in several domains. Thus, knowledge of knowledge of cognitive aging research is a critical means to achieving user-centered design for this particular population. Topics covered in this chapter include memory, spatial ability, attention, and text comprehension.

3.1 Age-related memory decline

Technology usage is dependent on different types of memory. Not only must an older adult remember the procedures involved in operating a device, but he or she may also be required to initiate use at specific times or simultaneously store and manipulate incoming information during use.

Age-related memory decline is not universal. Specific types of memory decline with age whereas others are spared.
(1) Working memory declines

**Working memory tasks** require temporary storage and manipulation of information in memory. Several theorists have argued that **capacity limitations, speed of processing limitations, and an inability to inhibit unwanted information** may underlie the age-related decline in working memory.

One example of working memory task is the automated telephone voice menu system. Older adults using telephone menu systems to inquire about their bank balances or the status of their utility bill are required to store and process the menu options while attempting to make navigational decisions. If the structure of the menu system is very broad such that a large number of options must be considered before a choice can be made, older adults may find themselves forgetting the content of the options because their working memory capacity is exceeded. Since only one option can be chosen at a time, all options other than the desired option must be considered as unwanted information and should be inhibited. Furthermore, if age-related working memory decline is due to reduced processing speed, the speed of menu item presentation is another factor to consider.

Possible design solutions: reduce the number of menu options should reduce working memory demands; present the most commonly requested menu item first, thereby reducing the need to inhibit unwanted options; slowing the speed of menu item presentation may also result in a more usable menu system for older adults.

(2) Semantic memory remains intact

Semantic memory refers to the store of factual information that accrues through a lifetime of learning. Remembering the meaning of vocabulary words, knowing the location of your doctor’s office, and recognizing words and symbols are all examples of semantic memory. Age-related differences in the organization and use of semantic information are only slight or nonexistent.

Use of metaphors is one mechanism that allows an individual to utilize specific prior knowledge from semantic memory to guide behavior in novel situations such as interaction with new technology. **Design strategies that capitalize on the existing knowledge base of older adults may result in more usable technology** because device operation is more intuitive due to its consistency with prior knowledge.

One familiar application of the metaphor principle is the Window computer desktop presentation where files and folders mimic how information is organized in a traditional paper-based desktop work area.
Prospective memory deficits vary by tasks

While working memory and semantic memory are forms of retrospective memory or memory for past events, prospective memory refers to remembering to do things in the future.

For an event-based prospective memory task, an environmental cue reminds one to perform a prospective task. Time-based tasks are largely self-initiated and require one to perform an action at a certain time or after a specified amount of time has elapsed. Age differences in prospective memory are usually much greater for time-based than event-based tasks.

An example of possible technology help: Use PDAs for reminding older adults to take their medications.

- By including environmental support in the form of a reminder or cue (e.g., auditory alarm by the PDA) that is specific to the task, time-based tasks can be transformed into event-base tasks.
- Because prospective memory tasks have a retrospective component (i.e., remembering what to do) and a prospective component (i.e., remembering when to do it), an effective intervention must support both (e.g., a visual display that provides specific instructions concerning what needs to be done).

3.2 Spatial abilities decline with age

The term “spatial ability” refers to one’s general ability to mentally manipulate images or patterns, for example, determining how to manipulate furniture so that it may pass through a door frame.

A normative decline in spatial abilities is associated here. Of particular interest here is the strong relationship between spatial abilities and older adults’ computer-based task performance that require high spatial ability such as navigating through a web site.

Design solutions to compensate that compensate for age-related changes in spatial ability:

- Inclusion of site maps and step-by-step navigational aids encourages older adults to visualize web-site structure and track their location within the website.
- Table of content and web-site indexes remove the necessity of storing menu information in the working memory.
Design solutions that capitalize on the semantic knowledge of older adults, e.g., architecture of a website is consistent with the pre-existing expectation and knowledge of older users, should also compensate for declining spatial abilities.

### 3.3 Age differences in selective attention are task specific

Selective attention is the cognitive mechanism used to filter out irrelevant information thereby allowing relevant information to be processed in memory. Reading a book in a noisy café illustrate one application of selective attention. Driving an automobile is another task that is highly dependent on selective attention.

Age differences in selective attention are task specific to the extent that semantic knowledge relevant to the task can be applied.

### 3.4 Older adults reading comprehension can be improved

According to the situation model approach to comprehension, readers create a mental model for the meaning of text by interpreting it in terms of what they already know (i.e., semantic memory) and drawing inferences. Older adults may be at a disadvantage when they have to draw inferences in novel situations where they cannot utilize their semantic knowledge.

Suggested design solutions for written instruction such as those presented on home medical devices:

- The use of large font sizes
- Simplified sentence structure
- Nontechnical terminology presented at a sixth-grade reading level at maximum
- Use of explicit signals that highlight the main ideas and relations in the text
- Procedures should be explicit stated so that the older adults do not have to rely on inferential information

### 3.5 Conclusion

Technology can be used to augment intact abilities and compensate for abilities lost due to age-related cognitive decline. Design solutions can and should be combined due to the interactive nature of the cognitive principles. Technology should not be designed based on one cognitive principle alone but instead of should be evaluated with respect to systemic cognitive function.
Unlike earlier examples that described the application of a single device to support specific problems, ubiquitous computing offers intervention on a much larger scale to support a variety of daily activities. Smart environment designers face the challenge of developing a system that operates to support systemic cognitive function by simultaneously targeting multiple cognitive aging principles.