A Taxonomy of Technology for Cognition

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A Taxonomy

- Supports systematic review of literature
- Aids in comparing/contrasting approaches
- Suggests new and overlooked approaches

The Taxonomy [1]

What cognitive process? E.g.,

- Reminding … what? when?
- Reminiscing … who? what? where? when?
- Finding … where?
- Executive functions
- Communicating

For whom, i.e., for which condition?

- Individual with impairment, e.g., amnesia, AD, MCI
- A "normally aging" individual

Possible goals, from least ambitious to most ambitious

- *Prosthetic* devices, *compensatory* for loss — Help in accessing needed facts, locations, procedures, reminders, etc.
- *Rehabilitative*, *restorative* aids improving specific capabilities
- *Preventative* devices delaying the onset of cognitive decline

Who is actually the "user"?

- Person with cognitive impairment
- Caregiver
- Collaborating cognition support team
- Impaired individual with help or by oneself

With what technology, e.g.?

- Desktop PCs, laptops, PDAs, cell phones, DVDs

What design approach is to be used, e.g.?

- User-centred design (UCD), design *for* users
- Participatory design (PD), design *with* users
- Patient-centered design, design for/with individual patient

Application of Taxonomy to Sample Projects

	Memory Book [2]	*Orienting Tool [3]*	*NeuroPage [4,5]*	*Multimedia Bios [6]*	*SenseCam [7,8]*	*Insitute for Cognitive Prosthetics [9]*	*Brain Excercises [10,11]*
Cognitive process	Reminding re medications & appointments	Orienting	Reminding re medications & appointments	Reminiscing	Reminiscing	Communications, organization, other cognitive skills	Improving cognitive performance in various ways
Participant population	Amnesic individuals	Amnesic individuals	Brain-damaged patients	Mid- or early-stage AD or MCI	One amnesiac individual	Individuals with TBI, stroke, other cognitive impairments	Normally aging seniors
Goals	Prosthetic	Prosthetic	Prosthetic + rehabilitative	Prosthetic + rehabilitative	Prosthetic + rehabilitative	Prosthetic + rehabilitative	Prevention of cognitive decline
Users, mode of use	Individuals	Individuals	Individuals with family "programming"	AD individuals + families	Individual with spouse	Individuals	May vary
Design method	UCD	PD + UCD	Not known	PD	UCD	Patient-centered design	Commercial products
Technology	Looseleaf note-books + bank of switches	Palm Pilot software	Pagers driven via telecommunications	Multimedia on DVDs	Portable automatic cameras	Desktop computers + telerehabilitation	Video and other games

Taxonomy Seems to be Promising

Helps situate/compare projects

Suggests new project directions

- Mike Wu's work with amnesics
  - *What kind of memory?*: From reminding to reminiscing
  - *For whom?*: From memory aids as individual prostheses to memory aids as collaboration technology
- Multimedia biographies
  - *For what impairment?*: From AD to other dementias, TBI
  - *By what process?*: From working with one or two family members to tools to allow dispersed families to collaborate

Suggests new projects

- Preventative goal (enhancing cognitive reserve)
  - *For what cognitive process? With what technology?*

Memory Book [2]

- Almost 20 years of research and clinical practice by Dr. Brian Richards & collaborators at Baycrest
- Patients who have anterograde amnesia
- Physical "memory book"
- Patients trained to:
  - Transcribe next day's events into looseleaf binder
  - Set alarms for time of events
  - When alarm goes off, open book, turn off alarm, read "to-do", do task (e.g., take pills, go to the doctor, walk the dog), close book
- **Outcome**: system effective and in regular use by patients, now re-implemented on Palm Pilots

Orienting Tool [3]

- M.Sc. Thesis of Mike Wu (Dr. Brian Richards, Baycrest, research partner)
- Participatory design with a team of 6 individuals who have anterograde amnesia
- Result was a Palm Pilot orienting aid
- **Outcomes**: Greater independence, self-confidence

NeuroPage [4,5]

- Reminding system: messages transmitted to lightweight portable pager
- Messages "programmed" by caregivers
- Medium-term (16 weeks) RCT on 143 brain-damaged individuals (Dr. Barbara Wilson)
- **Outcomes**:
  - More than 80% significantly more successful in carrying out everyday activities (e.g., self care, self medication, keeping appointments) compared to baseline
  - For most of these, significant improvement still maintained 7 weeks after returning pager

Interactive Multimedia Biographies [6]

- M.Sc. Thesis of Tira Cohene (Prof. Elsa Marziali, Baycrest, research collaborator)
- DVD-based multimedia bios for reminiscing
- For individuals with AD or MCI and their families
- Primarily prosthetic, somewhat rehabilitative
- UCD for process, PD for biography
- **Outcomes**: Engagement (mostly enjoyment), enhanced memories, more communication with family, legacy for family

See presentation: Monday 1:30, session T1.8, Civic Boardroom

SenseCam [7,8]

- Lightweight portable camera that snaps wide-angle medium-rez pictures automatically every 30 seconds or whenever sensors record changes
- Visual "digital experiences" easily viewed on a PC
- First outcomes:
  - Significant gain in recall by one amnesic individual up to 1 year later after 7 review sessions of SenseCam records
  - Similar patterns seem to exist with two AD individuals
- Huge excitement in neuropsychological rehab community, but some privacy concerns

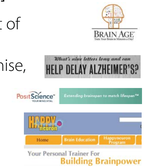
See poster: Monday poster session NP.6, Dominion North

Institute of Cognitive Prosthetics [9] Software

- Dr. Elliot Cole, Philadelphia PA.
- Work over 20 years with 100 individuals with conditions such as TBI and stroke
- Patient-centred design process
- Software for easily tailoring communications and information management tools to meet individual patient needs
- Exploits "islands of abilities" in "seas of deficits"
- Enables self-sufficient performance of tasks that previously required active caregiver intervention

Brain Exercises ("Use it or Lose It") [10,11]

- Can we slow down cognitive aging, and delay the onset of Alzheimer's disease?
- Huge commercial activity, huge controversy, huge promise, cognitive reserve concept [12]



"Conclusions. This study demonstrates robust evidence that complex patterns of mental activity in the early, mid- and late-life stages is associated with a significant reduction in dementia incidence. Randomized control trials based on brain-reserve principles are now required." [10]

"...very few studies have found an interactive effect of age and mental activity on measures of cognitive functioning. Despite the current lack of empirical evidence for the idea that the rate of mental aging is moderated by amount of mental activity, there may be personal benefits to assuming that the mental-exercise hypothesis is true." [11]

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