Cognitive Assistive Technology: Who and How?

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Disclosures

- I have no financial relationships to disclose.
- Discussion of particular products during the course of this talk does not equal endorsement of specific brands.

Objectives

- Outline broad classes of assistive technologies for cognition
- Identify general populations who may benefit from CAT for rehabilitation or compensation of lost/failing function
- Summarize what we know regarding the effectiveness of CAT as well as training strategies to enhance implementation

Goals of CAT

- Improve functional activities to…
  - Enhance independence in home/community
  - Enhance quality of life
  - Reduce caregiver burden
  - Reinforce residual ability
  - Substitute alternative methods for task completion
- Restore function…

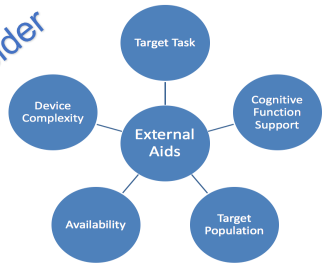
Gillespie et al., 2012; Kirsch et al., 2004; LoPrestiet al., 2004; Scherer et al., 2005

Computerized Cognitive Rehabilitation

- Evidence is weak
- Marketing Claims are false, but…
- CCR has:
  - resulted in improvements in attention/memory when combined with traditional therapies for patients with CHI
  - shown improvements in BOLD response on fMRI, neurospych testing and behaviors in a case study of a woman 16 years post severe TBI
  - demonstrated limited, positive changes in normal aging adults
- Affective benefit

Middelton et al., 1991; Laatsch 2004; Mayas, 2014; Ballesteros, 2014; Rigaud et al., 2008

Factors to Consider



Target Population

- TBI, CVA
- Dementia
- RHD
- Mental Illness
- Genetic Disorders/Perinatal Insults
  - Down Syndrome
  - Autism
  - Dyslexia, ADD/ADHD, Dyscalculia

Examples of Cognitive Deficits

- Attention
  - Limited ability to filter distractions, shift attention
- Visual Processing, Visual-Spatial Processing
- Memory
- Executive Functions
  - Discrepancy between knowing (saying) and doing
  - Planning/Problem Solving/Organization
- Affective Behaviors/Behavioral Regulation

Target Task

- Multi-functional
- Specialized Task

Availability

- Commercial
- Clinician Generated
- Clinician Adapted

Device Complexity

- High Tech
- Mid Tech
- Low Tech

Cognitive Function Support

- Memory
- Attention
- Executive Functioning
- Speech/Language

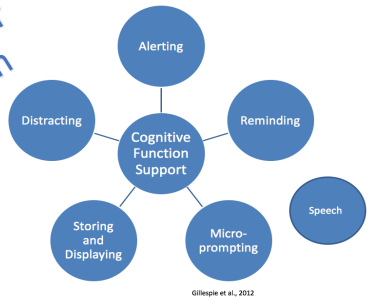
- Low tech/task specific
  - Calculator
  - Electronic speller
  - Pill box
  - Map
  - Step-by-step instructions written on appliance
- High tech/task specific
  - Software programs
  - GPS
  - Smart pens
  - Literacy Software
- Low tech/multi-function
  - Post-Its
  - Appointment calendar
  - Checklists
- Mid tech/multi-function
  - Data watches
  - Voice recorder
  - Cell phone
- High tech/multi-function
  - Smart Phone
  - Tablet
  - SGD

Changing Face of CAT

- 95% of Americans own a mobile device
- 77% of American own a smartphone
- 1 in 10 Americans are smartphone users only – (i.e., no broadband internet)
- 46% of adults say they could not live without their smartphone

Pew Research Center, 2017

Framework for Organization

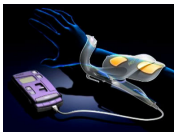


Gillespie et al., 2012

Alerting Devices: Attention

- Draw attention to a stimulus that is present in external/internal environment
- Examples:
  - Neglect Alert Devices
    - EVIDENCE: positive outcomes for mobility and visual search tasks
  - Devices that call attention to goals
    - Redirect to internal goal representations/Improve on-task behaviors and memory for goals
    - EVIDENCE: effectiveness for content free cueing (tones or "stop")

Fong, 2013; O'Neill & McMillan, 2004; Robertson et al., 2002; Fish et al., 2007; Manly et al., 2004; Culley & Evans, 2010; Hart et al., 2002; Kirsch et al., 2004



BioNess

Apple Watch

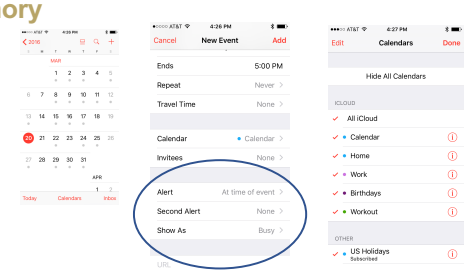
WatchMinder3

Reminding: Prospective Memory & Planning

- Provide a one-way, time dependent reminder about something not in the immediate environment which is intended to be an impetus to action
- Examples
  - Time management most commonly targeted by CAT
    - Largest study NEUROPAGE
    - Voice recorders with timer function, text messaging, voice messaging, reminder functions on smartphones or schedule software on PCs
    - EVIDENCE: Effectiveness of successful use is strong, but some studies with mixed results
  - Planning and Organization: step by step support during task performance
    - Software, multimedia (visual/auditory feedback), apps
    - EVIDENCE: increased accuracy of steps for task completion with CAT across several studies compared to low tech/no tech options (small n)

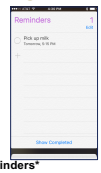
Wilson et al., 2001; Yasuda et al., 2002; Stapleton et al., 2007; Lancioni et al., 2000; O'Neill et al., 2010

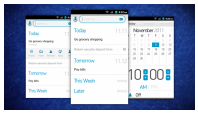
Time Management/Organization/Prospective Memory

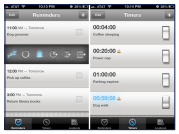


Calendar App - iOS

Time Management/Organization/Prospective Memory







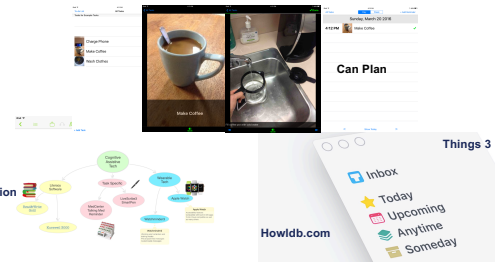
Reminders*
Due*
To-Do Cloud***
Things*
Any.Do***
Wunderlist***

*iOS **Android ***iOS & Android

Planning/Organization/Microprompting

- **Thought organization**
  - **Semantic mapping**
- **Complex activity planning/execution**
  - **Trips**
  - **Housing**
  - **Academic Projects**

Planning/Organization/Microprompting

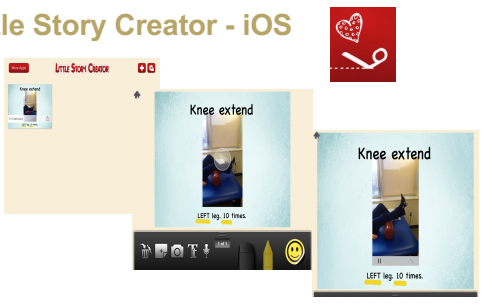


Storing and Displaying Devices: Memory

- Store and present episodic memories (no time dependent impetus to action)
- Examples
  - Cameras
    - Improvement in episodic memory in subject with autobiographical memory impairment
  - Multimedia Reminiscence
    - Interactive system with photos/audio designed to trigger memories which the user can talk about
- Evidence: Limited empirical evidence. Qualitative or single subject designs.

Berry et al., 2007; Alm, et al., 2004

Little Story Creator - iOS



Distracting Devices: Emotional Regulation


Beats by Dre

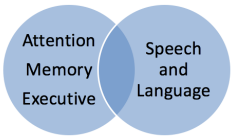
- Distract users from anxiety provoking stimuli
- Examples
  - Personal stereo use for managing distress of auditory hallucinations in schizophrenia
    - EVIDENCE: positive outcomes but low methodological quality (i.e., self-report in largest study and case reports)
  - Biofeedback in anxiety and depression
    - EVIDENCE:
      - Reduction in anger and anxiety (in conjunction with CBT) for those with anxiety disorders
      - Effective for improving physiological and psychological health for individuals with PTSD

McInnis & Marks, 1990; Johnston et al., 2002; Nelson et al., 1991; Reiner, 2008; Zucker et al., 2009;

Speech Generating Devices

- Standard practice for adults with neurodegenerative disease
  - effective, functional individualized communication systems to allow active participation in daily activities throughout lifespan
- Early referral, regular re-evaluations and continual treatment are essential
- Communication partners must be included from the onset to establish AAC acceptance and use
- Strategies will change over time and use multiple modalities to capitalize on communicators' strengths

CAT and TBI



- Younger tend to compensate better
- Very severe impairments can be negative prognosticators
- Focal deficits tend to result in more favorable outcomes
- Premorbid use of compensatory aids enhances uses after injury

Sohlberg, 2011

TBI and SGD, specifically

- ~40% of people who do not regain natural speech by the middle stage of recovery (Rancho Levels V and VI) remain unable to speak due to chronic, severe motor speech or language disorders.
- 94% of people with TBI/caregivers accepted the AT recommended to them
  - After 3 years, 81% continued to use their technology
- How should language be organized for some with TBI?
  - Evaluation of how an individual categorizes semantic information is important
  - More efficient target location for icon-only noun grids than for text-only or icon-plus-text grids when using eye tracking has been demonstrated

Dongilli et al., 1992; Ladtkow & Culp, 1992; Fager, 2006; Brown, 2015a,b; Wallace; 2010

Barriers to Successful CAT Use

- Funding
- Clinician/Client unfamiliarity
- Poor pairing of device/patient
- Availability of range of devices
- Changing technology
- Complexity/cognitive demands

- Lack of systematic training with device
  - Systematic Instruction vs. Trial & Error
    - Systematic Considers: Task Complexity, Practice Regimen (errors, practice distribution, stimulus variability), Cueing and Feedback
    - Trial & Error: ASSUMES learner can learn from their mistakes

Hart et al., 2003; Kirsch et al., 2004; Maas et Al., 2008; Montessori & George, 1912; Scherer et al., 2005; Sohlberget al., 2007; Wang et. Al., 2016.

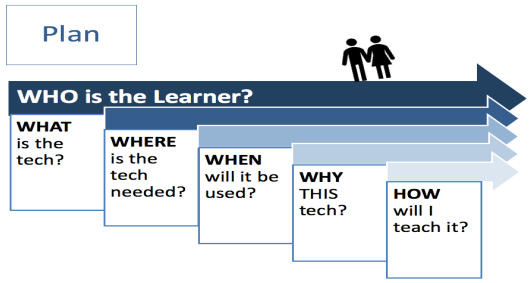
P.I.E. Model

- Planning: Many critical decisions are made outside of therapy session including careful needs assessment.
- Implementation: Need to use methods to maximize efficiency & durability of learning; decisions & clinical behaviors implemented during the session.
- Evaluation: Importance of evaluating client performance within and outside of session; measuring outcome and learning.

Sohlberg & Turkstra (2011)

4 step process

1. Become familiar with range of CAT tools
   (planning)
2. Conduct individualized needs assessment
   (planning)
3. Train use of device
   (implementing)
4. Measure effectiveness
   (evaluating)



Inventories for Planning…and Outcomes

- CTI - Compensation Techniques Inventory (Sohlberg& Turkstra, 2011)
- MPT - Matching Person and Technology (Scherer & Craddock, 2002)
- SADI - Self Awareness of Deficit Interview (Fleming and Strong, 1995)

Implement

Systematic Instruction (including errorless learning, spaced retrieval)	Conventional Instruction
Limited range of instructional targets (e.g., only calendar app at first)	Broad range of instructional targets (train multiple apps)
Multiple training examples	Few training examples
Mastery emphasized	Mastery not emphasized
Exploration discouraged	Exploration encouraged
Step-by-step models, carefully faded support	Whole-task models
High rates of correct, distributed practice and review per target	Few practice opportunities per target
Immediate corrective feedback	Feedback after task completion
Training in different environments	Training primarily in clinic setting

Schlberg & Turkstra (2011)

Acquisition-Maintenance: Instructional Sequence

- Begins with modeling and explicit cues
- Learning supports
  - Checklist with steps
  - Written cue cards
  - Environmental cue (alarm)
  - Talking through each step as it is implemented
- Internalization of steps
  - Retain over time with increased time intervals
- Fading of learning supports
- Increasing stimulus variability
  - New people, environments
- Increasing engagement
  - Customized log as concrete record of benefit
  - Collaboration to ID benefits/barriers
- Maintaining
  - Plan for abandonment

Automatic & internalized = high frequency CORRECT practice

Evaluate

Session | Generalization | Maintenance

Impact | Efficacy

Potential Outcome Tools

- Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST)
  - Demers, et. Al., 2012
- Matching Persons to Technology (MPT)
  - Scherer & Craddock, 2002
- Caregiver Assistive Technology Outcome Measure (CATOM)
  - Mortensen, et., Al., 2015
- Psychosocial Impact of Assistive Devices Scales (PIADS)
  - Jutai & Day, 2002
- Assistive Technology Outcomes Measurement System (ATOMS)
  - Edyburn & Smith, 2004

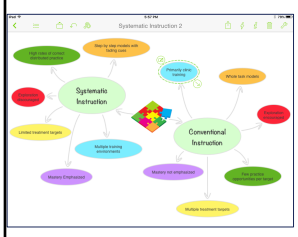
Case 1: Aaron

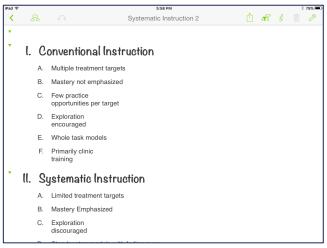
- 28 y/o s/p blast exposure; concussion
- PTSD, anxiety d/o, h/o alcohol abuse
- Mild attentional fluctuations on neuropsych testing likely accounting for functional complaints regarding memory, organization

- Plan
  - Collaboration between SLP/Psychology/Veteran to outline barriers
  - Establish Goals:
    - Apply strategies from psychotherapy
    - Organize daily activities to reduce frustration/anxiety
    - Return to school, successfully

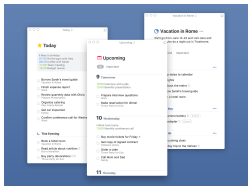
- Implement
  - Assistive technologies for attention and organization
    - Tablet in conjunction with personal smartphone and education/training for return to school
    - Train one application at a time, in session with guided instruction and self-discovery (some trial and error)
      - Inspiration, Things, & Notability (for him)
  - Self-efficacy resulted in immediate generalization of applications
- Evaluate
  - Within sessions, self-report

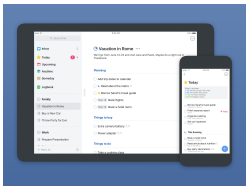
Inspiration Maps - iOS





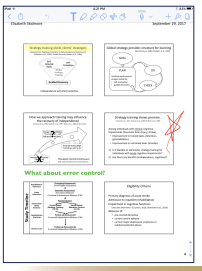
Things 3 - iOS



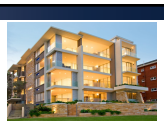


Illustratedstudy.com

Notability - iOS



Case 2: Sam



- 64 y/o male s/p R MCA stroke
- LEFT hemiparesis, dysarthria, dysphagia
- h/o right frontopartietal and pontine infarcts, current smoker, HTN, alcohol abuse, COPD
- Transfers, mobility, and balance concerns
  - Better leg return than arm
- L wrist cock-up splint for use with mobile arm support, sublux cuff, L AFO, standard and wide notch sock aids, one-handed nail clippers, custom-fit shoulder support/sublux cuff, GivMohr sling
- Mild impairments in attention/memory/visuospatial skills only. Difficulty during functional tasks and daily activities, particularly in the context of environments with multiple distractors.

The Problem

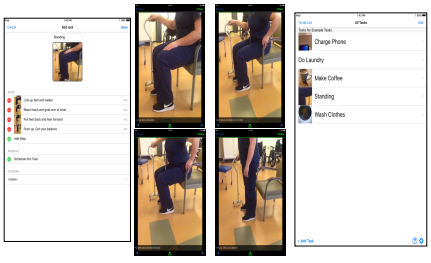
- Difficulty retaining and executing sequences for safe transfers
- Overestimation of abilities
- Left hand/arm – inattention to the LEFT side at meal times, during other functional activities

- Plan
  - Collaboration between PT/OT/SLP to outline barriers, previous training methods
  - Establish Goals: Return to independent living
    - Use/maintain movement of LUE
    - Don/doff equipment, clothes
    - Transfer safely, fall recovery
    - Ambulate with assistive device
    - Increase awareness of limitations
    - Enhance execution of multi-step commands

- Implement
  - Assistive technologies for attention and multistep sequences
    - Introduction of an alert reminding device on LEFT arm to increase awareness/use
      - Remember, memory is a strength
    - Tablet for multi-step commands
      - CanPlan
  - Multiple discreet trials for complex sequences with repetition until mastery is achieved
    - No advancement without mastery
    - Collaborative and consistent treatment
    - Increase awareness via prediction and reflection
  - Transition of same process/skill to nursing unit and family
- Evaluate
  - Within sessions, across environments (facility and community), family and nursing staff involvement

Wobl8

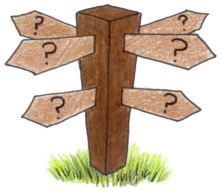
CanPlan - iOS



Case 3: Doug

- 30 y/o male veteran who sustained catastrophic injury after stepping on a dismounted improvised explosive device
- 6 years status post the blast injury which left him with severe TBI, bilateral above the knee amputations, bilateral CVAs to include the left MCA territory and right frontal/basal ganglia regions, shunted hydrocephalus, right hemiparesis and neglect, and left hemiballismus
- Severe apraxia, aphasia, non-verbal
- Functional communication limited to facial expression and eye movements with those who know him well

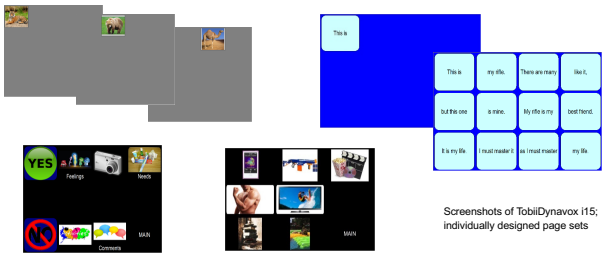
The Problem



- Plan
  - Collaboration between PT/OT/SLP to outline individual and collaborative goals
- Implement
  - Assistive technologies for attention and communication
  - Co-treatment
- Evaluate
  - Within sessions, across environments, family report

What does this look like? (SLP perspective)

- Error control visual tracking practice of left to right eye movement, using highly motivating visual targets and personally relevant stimuli
- Systematic increase of task complexity in regards to resistance to distractions
- Transition to functionally relevant page set targets, continuing error control training model



Screenshots of TobiiDynavox i15; individually designed page sets

Implementation of Co-treatment

- OT/PT
  - Improved functional use of upper extremities
    - Increased wearing time of R BioNess device to progress to functional task
  - Increased awareness of muscles on neglected side & core (i.e., active contraction)
    - Postural training in Sky Lift with body harness to decrease right lateral rotation while standing
  - Increased prosthetic wearing time
    - Ambulation in Sky Lift with WW, focus on circumduction during stepping and forward progression (staff assist with prosthetic advancement)
  - Maintain current function and prevent arthritic/bone conditions
  - Reduced Caregiver Burden
- SLP
  - Carryover of RIGHT attention training and functional application of communication device

What have we seen?

- Generalization of improved attention to the right side beyond the screen of the SGD to novel situations in the environment
- Increased functional use of SGD to indicate preference
- Increased wearing time of BioNess
- Supported execution of functional activities using UEs
- Reduced staff support for posture (physical/stimuli for attention)
- Active muscle contraction…when focused.

Evidence for Systematic Instruction

- RCT; double blind; pre/post-test
  - N=29
  - ABI, Moderate-severe cognitive impairments
- Compared systematic instruction with conventional instruction for teaching use of PDA
- No significant difference in post-test on measures of accuracy & fluency
- Systematic Instruction resulted in generalization
- Systematic Instruction more powerful at 30 day follow-up

Ehlhardtet al., (2012)

Systematic Instruction: Candidacy Themes

- Type/Level of Impairment, Disease Characteristics
  - Impulsivity, Visuospatial deficits, Memory Impairments
- Task/Technology Complexity
- Personal Variables
  - Expectations, Self-efficacy, Psychosocial Status

In Summary…

- There are a wide range of CAT interventions
- CAT might be appropriate for individuals you might not otherwise consider
- Combining CAT with traditional cognitive/language therapies can bring about powerful results
- Consider utilizing systematic instruction more often
  - Recognize who might benefit from a more structured/systematic approach to learning
- Collaborate with your team members
  - work together towards the common goal
- Without proper evaluation and training, the CAT won't succeed.

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