COMPUTER-BASED BRAIN FITNESS PROGRAMS FOR TRAUMATIC BRAIN INJURY REHABILITATION

Katherine W. Sullivan M.S., CCC-SLP, CBIS

Walter Reed National Military Medical Center

Center for Neuroscience and Regenerative Medicine

Defense and Veterans Brain Injury Center

Disclaimers

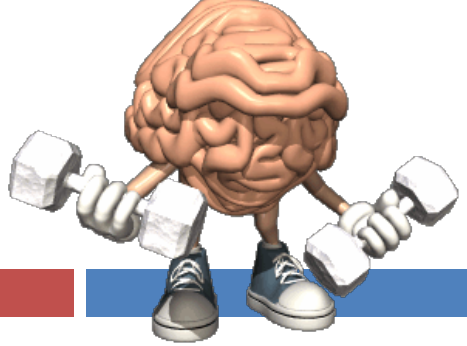
The views expressed in this lecture are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Army, or Air Force, the Department of Defense, nor the U.S. Government

This presentation does not

imply any Federal/DOD endorsement

I have no relevant financial or nonfinancial relationships with the products described, reviewed, evaluated or compared in this presentation

Unclassified



Goals

- Describe the Brain Fitness Center (BFC) at Walter Reed National Military Medical Center (WRNMMC)
- Demonstrate a variety of the programs used in our BFC
- Discuss ways to choose the right products for your setting and your patients
- Provide tips and tools for starting a similar “Brain Gym” concept at your facility
- Review evidence-based research in the literature and ongoing studies at WRNMMC

Patient Population

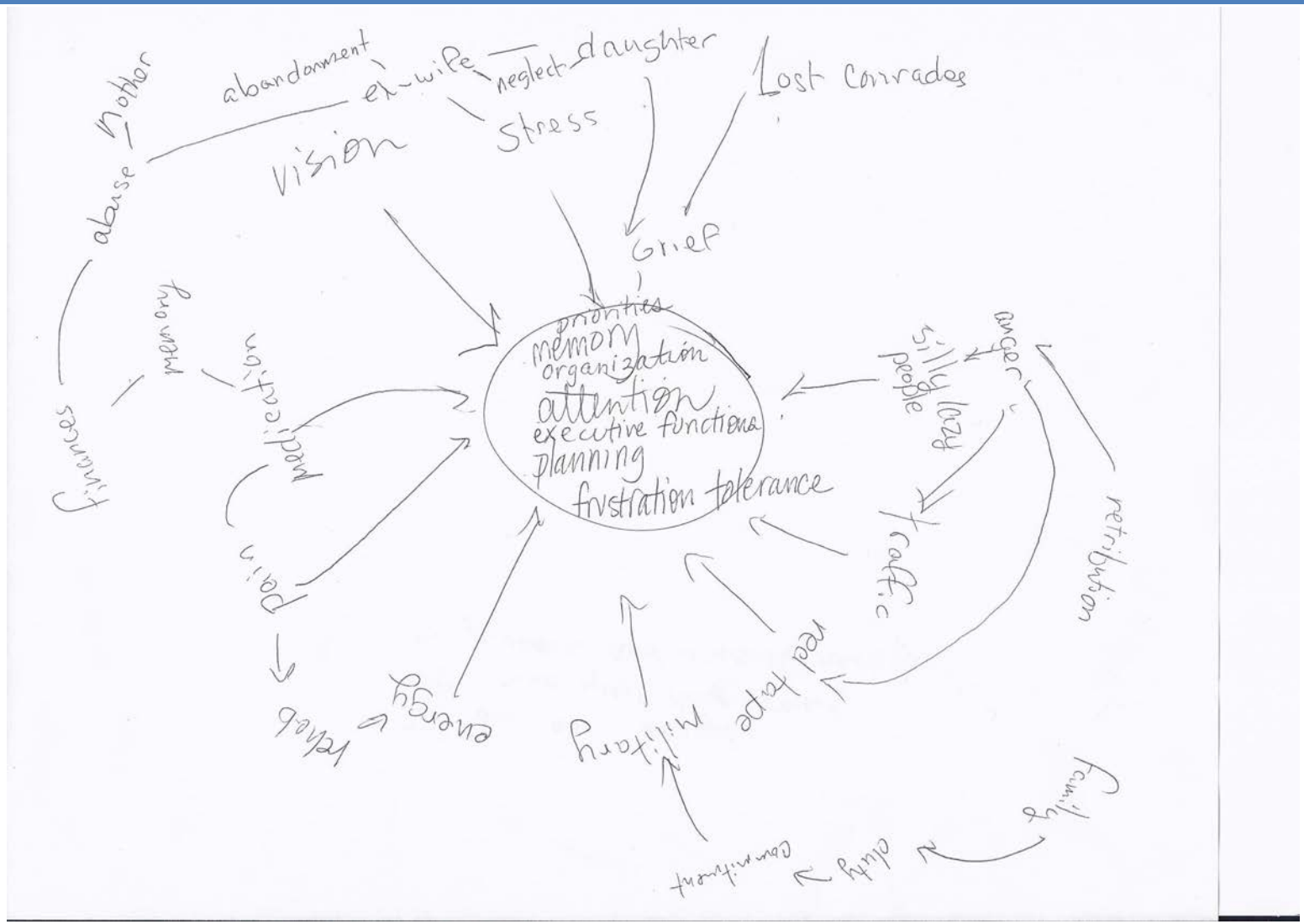
Wounded Warriors are Unique

Post-Deployment Syndrome

- Co-Morbidities
  - Poly-trauma
  - PTSD
  - Other(s)
- Prolonged transition phase
- Future (employment, living, family) is often unknown
- Blast injuries similar to civilian mTBIs, or not?

Lessons Learned May or May Not Translate to Civilian Care

24 year old male injured in OEFin an IED blast in December of 2010. He was diagnosed with a mTBI and is receiving cognitive rehab for the complaints listed in the circle below



Providing Novel Rehabilitation Approaches for our Population

Walter Reed National Military Medical Center (WRNMMC)

Identified a population:

Any OIF/OEF service member with subjective complaints of cognitive dysfunction

Determined access:

225-250 service members with the diagnosis of a traumatic brain injury (TBI) living on base at any time

Continue to learn if appropriate:

Mostly a very motivated, self-driven population; however, not always medically stable, available for ideal dosing, or typically of mTBI

Brain Fitness Center

Walter Reed National Military Medical Center

- Opened its doors in November of 2008 with clinical, research and education goals

- To serve the 225-250 service members with the diagnosis of a traumatic brain injury (TBI) living on base at any given time

- Will see any patient with *subjective* cognitive complaints following deployment

Walter Reed Brain Fitness Center Goals

Clinical

- Supplement cognitive rehabilitation by using computer-based programs to enhance recovery

Education

- Create a center for cognitive and TBI resources for patients and their families

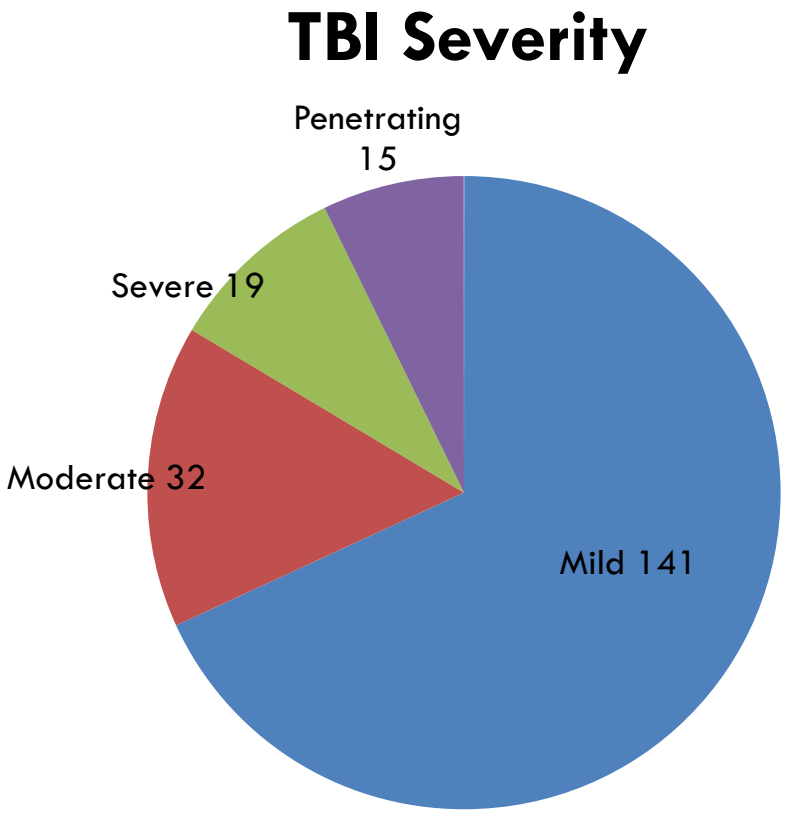
Research

- Develop and implement research protocols to improve our understanding of computer-based cognitive rehabilitation outcomes

Total BFC Patient Population

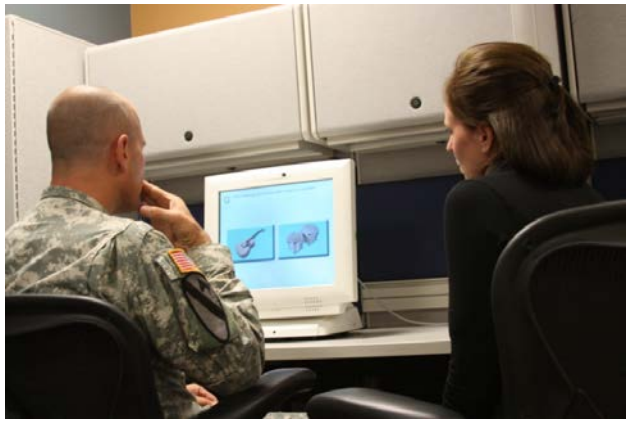
as of November 2012

- 307 Patients have visited the BFC
  - 207 TBI
  - 100 Other CVA, PTSD, ADHD, Aneurysm, Chemofog etc.
- Average of 24 Sessions (1 to 300+) in 96.0 BFC days



Patient Participation

- BFC patient participation is individualized based on:
  - Referral request
  - Guided recommendation (goals, complaints, severity)
  - Patient preference
- Goal of daily 6-8 week program
  - A second or third 6-8 week program is available for appropriate patients
  - Not always realistic
- Communication with providers
  - Rehab rounds, family meetings, etc.
  - Notes in medical charts
  - Other as needed



BFC Clinical and Research Outcomes Measures

- Objective cognitive assessments and self-report questionnaires are utilized at the time of the intake evaluation, at approximately 6-8 weeks, and at the time of discharge or discontinuation.
  - Automated Neuropsychological Assessment Metrics (ANAM)
  - Mayo-Portland Adaptability Inventory-4 (MPAI-4)
  - Neurobehavioral Symptom Inventory (NBSI)
  - Satisfaction with Life Scale (SWLS)
  - Post-Traumatic Stress Disorder Checklist – Civilian Version (PCL-C)

How Brain Training is used at WRNMMC?

Average patient visits: **112 per month**

- Different reasons providers refer:
  - Cognitive training not compensation
  - Homework that can be intensive and monitored
  - Maintenance and transition for discharge with software
  - Schedule filler or distraction
- Different reasons patients stay:
  - Empowerment, self-betterment
  - Perceived or real functional benefits
  - Self-driven (select group); motivated

Brain Fitness Center Patient Satisfaction Survey

This computer program helped my recovery process:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.1

I thought the time commitment to the program was realistic and easy to accomplish:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.4

I found the content of the computer program to be fun and engaging:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.1

I found the content of the computer program to be appropriately challenging:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.4

I would like to have this computer program at home:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.1

I am glad I participated in this program:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.6

I would recommend this computer program to other service members:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.7

Access to education materials and a brain injury specialist was helpful:

0 Strongly Disagree | 1 Disagree | 2 Undecided | 3 Agree | 4 Strongly Agree

3.5

I felt this computer program helped me in the following areas (circle all that apply):

Memory **56**	Concentration/Attention **64**	Math **17**	Decision Making **28**
Real-world tasks **15**	Listening **52**	Visual tasks **38**	Vocabulary **14**

Results of the first 71 completed surveys:

Above: Number of participants, out of 71, who felt the program helped in various areas.

Left: Average responses to survey questions. 0 (Strongly Disagree) to 4 (Strongly Agree)

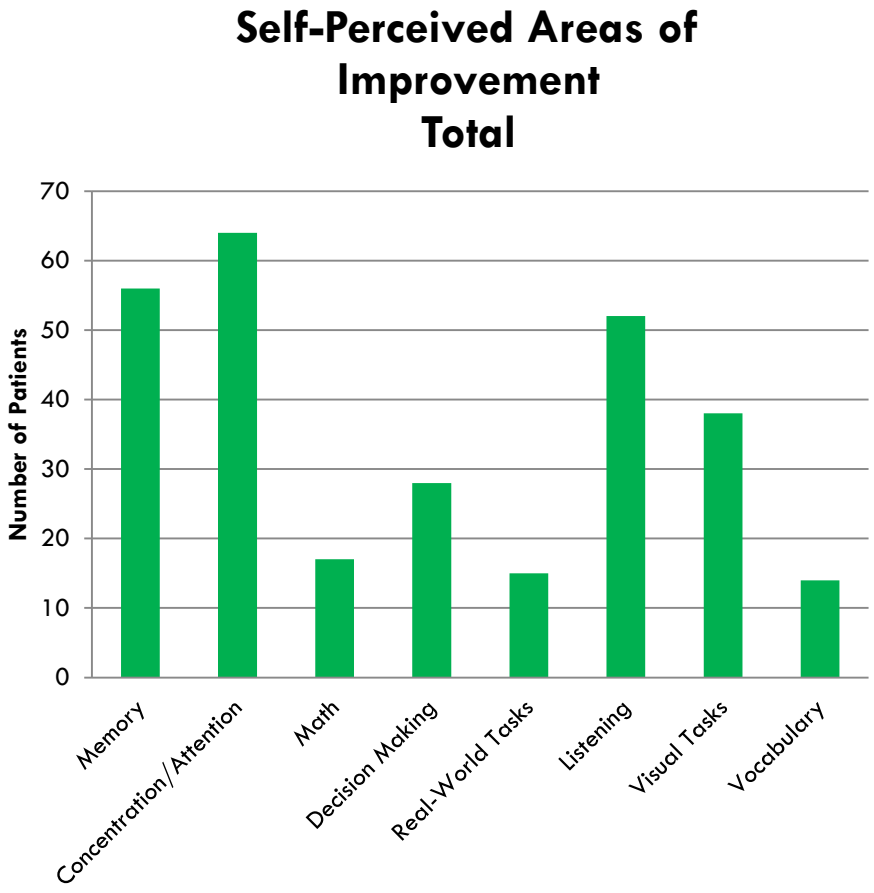
"Program is very worthwhile. Good learning environment and the progressive challenge is entertaining. I would love a copy of the program, and I believe each unit should have a program similar to the BFC." - Dr. Evil*

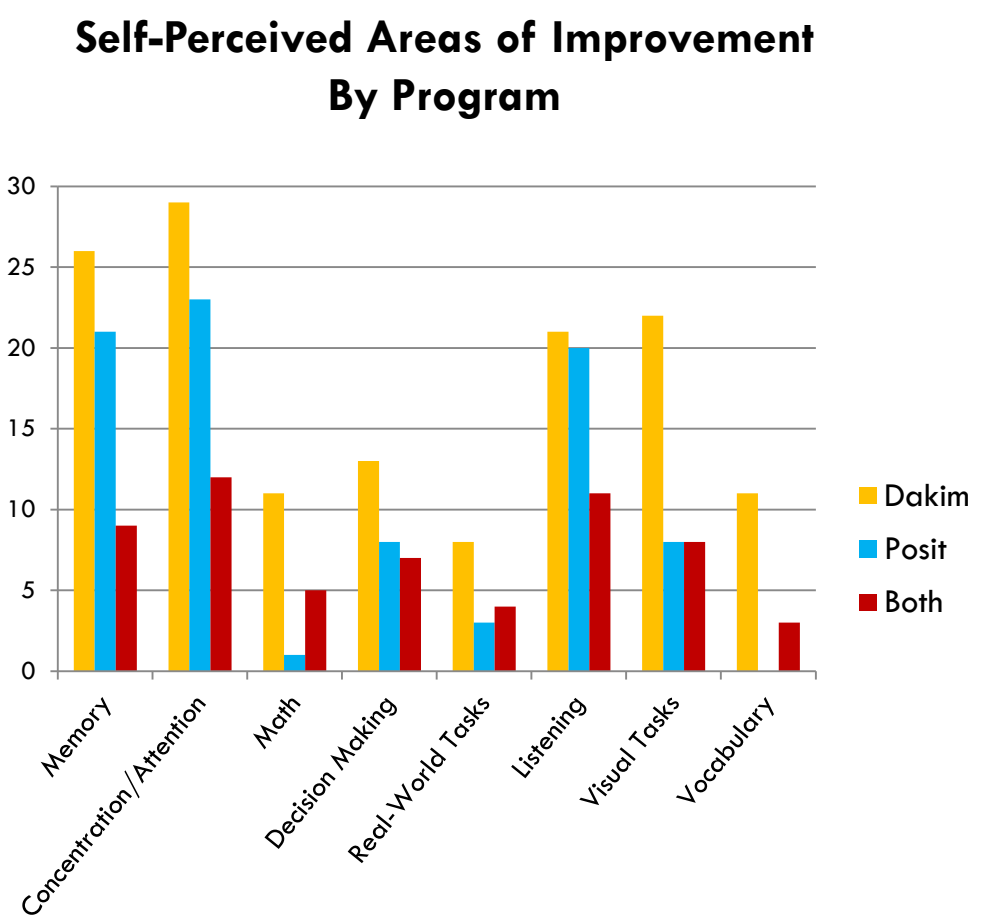
"Great program helped me in life/work environments… Recommend to everyone. This is good and very helpful." - John Smith*

"It has been a pleasure working with all of you guys in the Brain Fitness. I hope a lot of soldiers will take part in this. I benefit a lot from the Brain Fitness. Thanks again. Roger out." - Harrison Ford*

* Alias chosen and used by patient during each computer session

Patient Satisfaction
Per Program (33 Dakim, 28 Posit, 5 Both)





What is Brain Training?

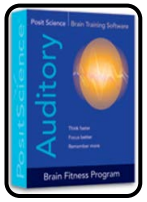
- Combination of research to support cognitive training (neuroplasticity) and a baby-boomer market has driven "brain training" mainstream

- Brain games
  - Cross-word puzzles 2.0
- Brain training
  - Defined as the structured use of cognitive exercises aimed at improving specific brain functions
  - Differentiates between mental activity and mental exercise

Programs available in the WRNMMC BFC

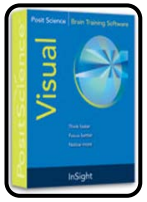
Dakim Brain Fitness

- Cross-Trainer



Posit Science - Classic

- Auditory Processing



Posit Science - Insight

- Visual Processing

Posit Science - BrainHQ

- Auditory, Visual, and Executive Functioning

Lumosity

- Web-Based, Cross-Trainer

Cogmed

- Working Memory

mPOD/OVEI

- Neuro and biofeedback

Nintendo DS

- Brain Age, Brain Age II

Mobile Applications

- Training on the go

Dakim BrainFitness

- Cross Training Domains:

  Short-term memory, long-term memory, critical thinking, calculation, visual-spatial, language

- Five levels of challenge
  - Level 1: No cognitive decline
  - Level 2-3: Age-related decline
  - Level 4-5 Mild-to-moderate cognitive impairment (MCI) or dementia

- Dynamically self adjusts
- Based on standardized neurological tests
- Scoring (satisfaction only)

Source: http://www.dakim.com

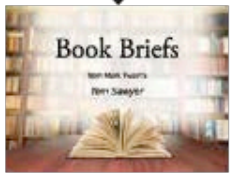
124 Types of Games

Dakim Exercises Based On Standardized Neurological Tests

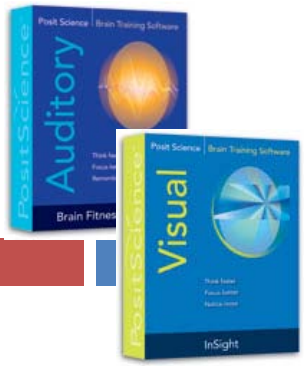
dakim BrainFitness

Domain: Short-Term Memory

Standardized Neurological Test/Exercise	Exercise Description	Dakim BrainFitness Exercise
• *Wechsler Memory Scale* • *Digits Forward Test*	Recall a sequence of numbers	• *Memory Mambo*
• *Point Digit Span* • *Letter Span*	Subject is instructed to point out a number or letter sequence read by the examiner on a large card on which the numbers 1 through 9 appear sequentially	• *Memory Mambo*
• *Recurring Figures Test*	Cards containing geometric or irregular nonsense figures are shown, with some repeating. Subject is asked to indicate which designs were seen previously.	• *Word Wager*
• *Picture Scanning of Behavioral Inattention Test*	Look at series of pictures carefully and both name and point out the "major items" in the pictures.	• *My Favorite Things* • *What's Unique*
• *Wechsler Memory Scale -III Family Pictures*		• *Odd Couples* • *Famous People Little Known Facts* • *Picture Pairs* • *Make a Story* • *Mazie's Face Finder*
• *Weschler Memory Scale-III* • *Hopkins Verbal Learning Test-Revised* • *Four Unrelated Words* • *Benson Bedside Memory Test* • *Auditory-Verbal Learning Test*	Recall words after incremental time delays	
• *Wechsler Memory Scale, Logical Memory* • *Memory Assessment Scales*	Examiner reads stories, asking subject for an immediate free recall of facts	• *Book Briefs* • *Keep Your Eyes Open* • *News Flash*

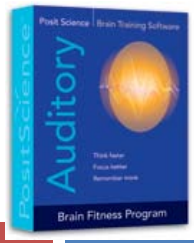


http://www.dakim.com/about-brain-fitness/personal-brain-fitness/video/



Posit Science

- Software to specifically target auditory (Brain Fitness Classic) or visual (Insight) processing
  - "Bottom-up: top-down" approach to fundamentally improve the brain's capacity to process information
  - Based on the principals of neuroplasticity and requires intense dosing
  - Research indicates improvements in processing, attention, memory and anecdotal reports of improved daily living
- New web-based program (BrainHQ)



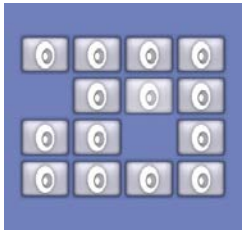
Posit Science: Brain Fitness Classic

HIGH OR LOW?
Encourages faster sound processing

SOUND REPLAY
Practices remembering information in order

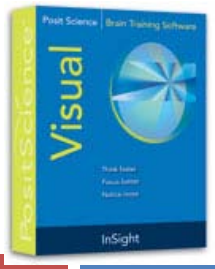
TELL US APART
Practices distinguishing similar sounds

LISTEN AND DO
Works out working memory, which is critical to many cognitive tasks

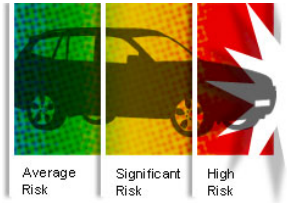


MATCH IT!
Sharpens precision of sound processing to improve memory of sounds

STORY TELLER
Promotes stronger memory for details to strengthen communication skills



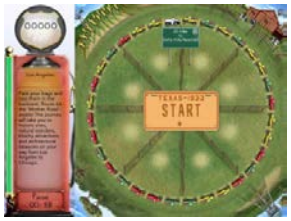
Insight Exercises



CRASH RISK EVALUATOR
Find out how much your brain notices in your peripheral vision and your crash risk

SWEEP SEEKER
Speeds up visual processing so you can spot and react to things more quickly

BIRD SAFARI
Sharpens your visual precision and expands your useful field of view



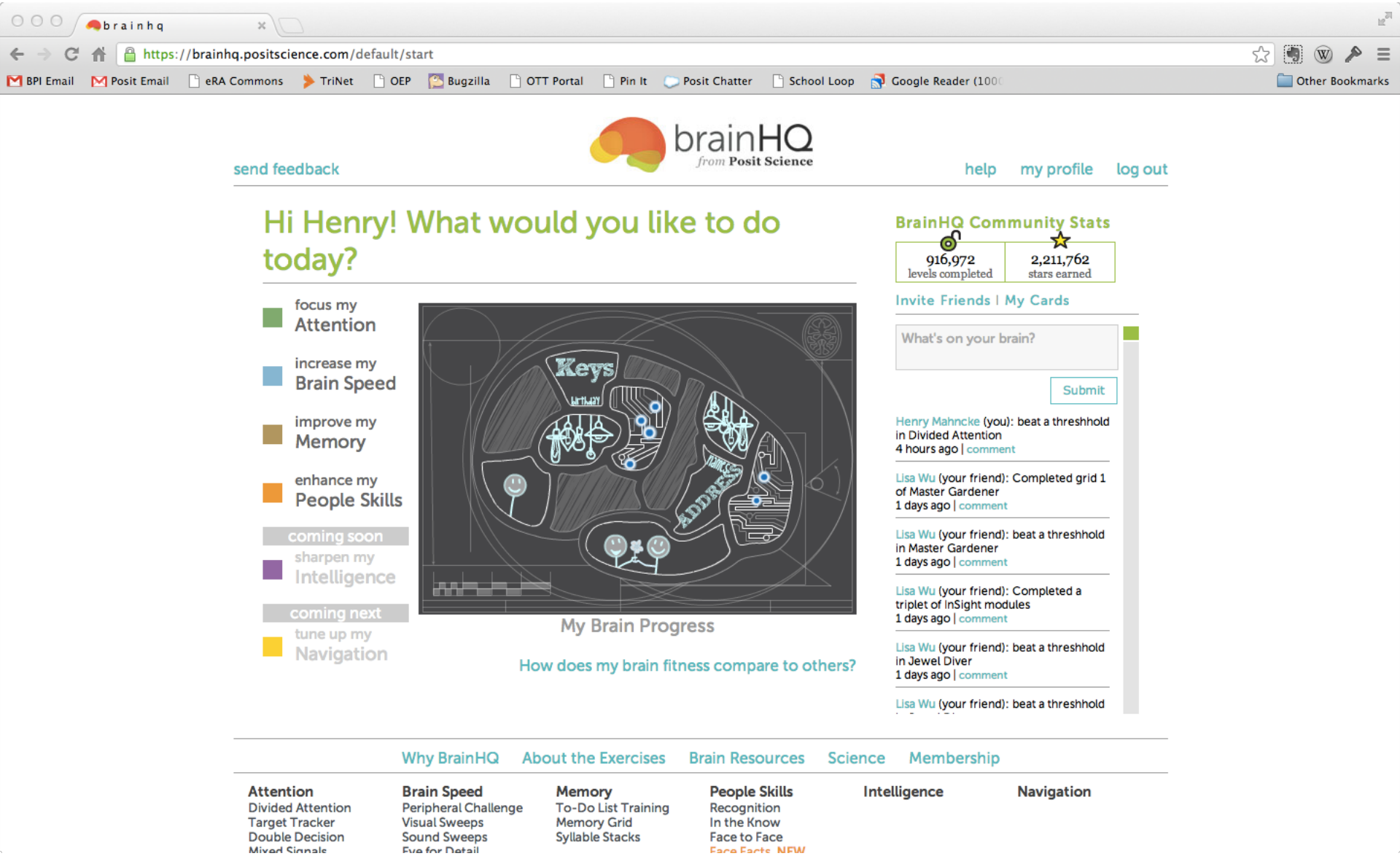
ROAD TOUR
Expands your useful field of view and speeds up processing for safer navigation

JEWEL DIVER
Exercises divided attention so you can track multiple moving objects at once

MASTER GARDENER
Works out your working memory so you can recall visual details

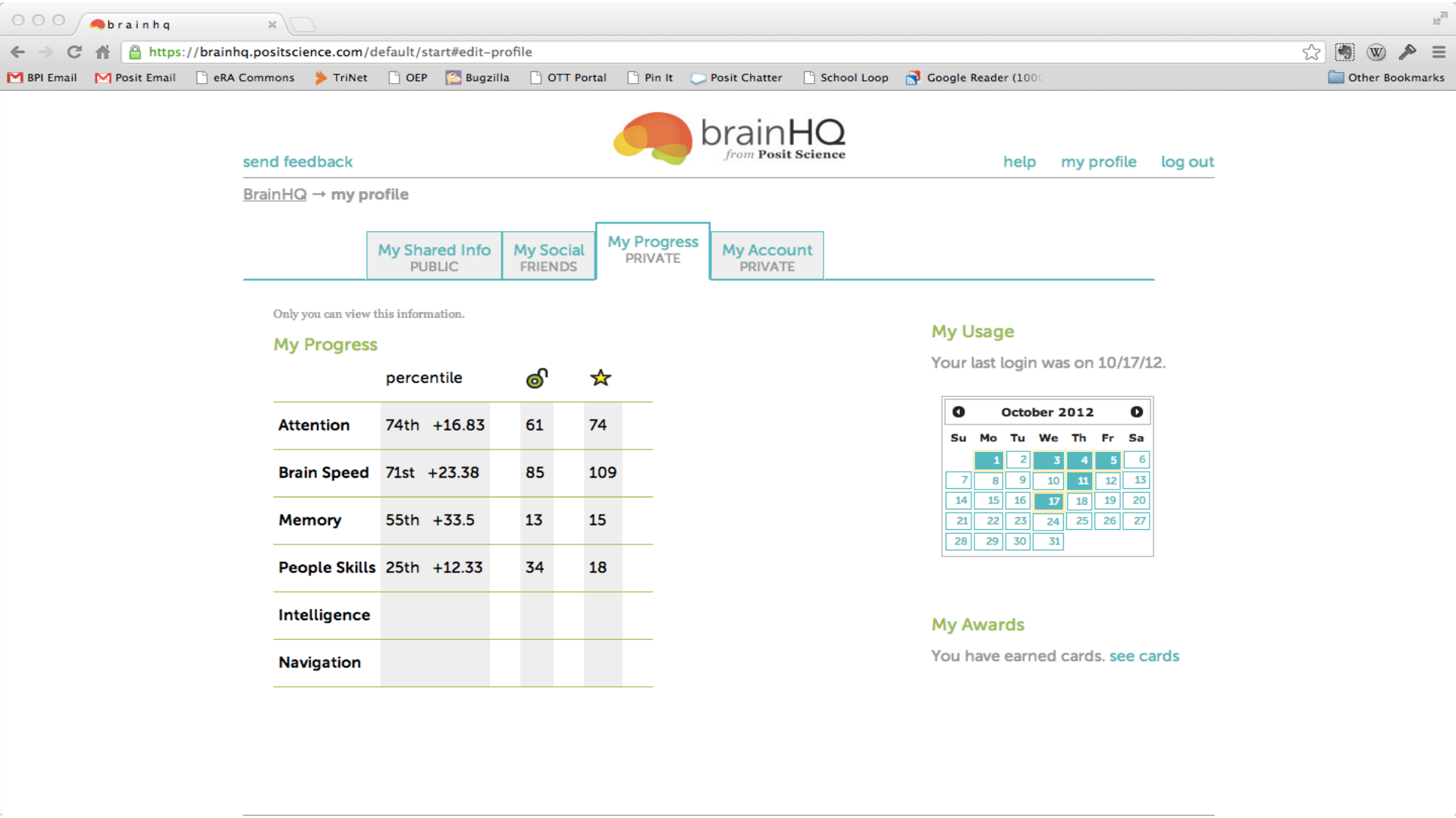
BrainHQ Dashboard

Progress and Friends



Usage and Progress Tracking

https://brainhq.positscience.com/pscweb-free/start



Lumosity

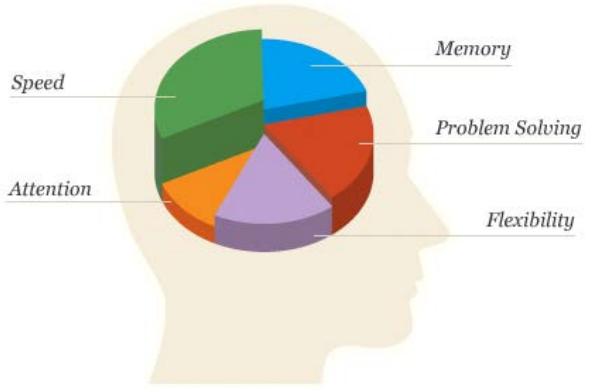
- Web-based brain games/training
- iPhone app available – allows continued training on the go
- Appropriate for school-age through adult
  - Easy to use
  - Adapts difficulty level based on progress of the user

Source: http://www.lumosity.com

Lumosity

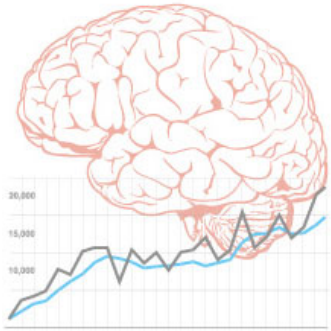
http://www.lumosity.com/

- Courses designed for users with specific medical conditions
  - TBI, PTSD, ADHD, Cancer
- Or, for targeting core cognitive abilities, such as:
  - working memory, visual attention and fluid intelligence



- Assessments allow users to track progress in:

Attention	Short-Term Memory
Flexibility	Processing speed
Spatial Memory	Working Memory



Cogmed

- Specifically targets working memory
  - Evidence-based program for improved attention
- The benefits of Cogmed training
  - Improves ability to focus and sustain attention
  - Leads to better complex reasoning skills
  - Improves professional and academic performance
- Intensive training
  - 25 training sessions over 5 weeks, 30-40 minutes each
  - Support by a Cogmed Coach
  - Can be completed in BFC or online at home

Cogmed

- 8 exercises per training session
- Remember and repeat a series of letters or numbers
- Track objects based on pattern, order, and position
- Dynamically adjusts difficulty level to match performance

- Training improvement index:

  Max Performance Level – Start Performance Level

mPod

- Personalized space designed for individuals to recover from stress and reach optimal levels of performance
- Patients are connected to biofeedback and neurofeedback sensors that measure physiological processes (muscle tension, breathing rhythms, heart rate, skin temperature, perspiration, and oxygen volume)
- Pending research at WRNMMC will compare results of bio and neurofeedback within the pod to feedback at a standard desk

Selecting Programs for your setting

- Consider population and typical cognitive complaints
  - Domain-specific programs
  - "Cross trainers"
  - Brain Games

- Decide if you want programs to be used independently or driven by a therapist
- Determine if a program's dosing requirements are realistic for your rehabilitation environment
- Understand your population's limitations (physical, emotional, etc.)
- Investigate any IT restrictions prior to purchasing programs
- Choose some programs that can be transferred for home use upon d/c
- If you have the resources – choose a variety!

Selecting Programs for your setting

Adaptability

- Programs should dynamically self-adjust
- Hold participants at an appropriately challenging yet not a frustrating level

Intensity

- Significant repetition to drive real change
- Process based to impact plasticity

Engagement

- Some means of feedback and rewards
- Fun to increase compliance and sustainability

Brain Training Software

Product Name	Pricing	Product Mode and Target Age	Brain Function	Recommended dosing by program
(m) Power by Dakim	$295 for home software $6-8,000 which includes software, hardware, and services that can be used by up to 12 users in clinical setting	Software program or complete system, ages 60 and older	Variety	40-60 minutes 3-5 times a week
Brain Fitness Classic by Posit Science	$197 for Auditory Software	Software Program, for adults	Auditory processing	40-60 minutes 3-5 times a week /6 -8 weeks
InSight with Cortex by Posit Science	$197 for Visual Software	Software Program, for adults	Visual processing	40-60 minutes, 3-5 times a week

Brain Training Software

Product Name	Pricing	Product Mode and Target Age	Brain Function	Recommended dosing by program
Cogmed	Contact company for exact pricing details ; estimated cost $1500	A licensed psychologist provides program ; three age specific software: pre-school, school-age, and Adults	Working Memory	35-45 minutes , 5 days a week / 5 wks.
Brain HQ by Posit Science	$10.99/Month $ 99/ year	Online, for adults	Variety	30 minutes, 3 times a week
Brain Age by Nintendo	$19.99 for the game, which needs to be played on the Nintendo DS ($129.99)	Handheld device, for all ages	Variety	Daily
Lumosity by Lumos Labs	$9.95/month or 70.95/year .	Online or App., for all ages	Variety	40 hours to reach benefit

Selecting Programs for Individual Users

Get to know your program(s) *and others on the market* then consider the following:

- Functional complaint and goals
- Referral source and request
- Severity Level
- Realistic dosing
- Appropriate mode
- Consider motivation
- Use your clinical judgment

THE SHARPBRAINS CHECKLIST™

10 Questions to Choose the Right Brain Fitness Program for You

How to Use: Answer all of these questions before you buy or use any product or service, computer-based or not, that makes any brain-related claims.

	Questions to Consider	Why
Based on Scientific Research?	1. Are there scientists (ideally neuropsychologists) and a scientific advisory board behind the program? 2. Are there published, peer-reviewed scientific papers written by those scientists? How many?	☐ Neuropsychologists are neuroscientists with a specialization in measuring and understanding human cognition and brain structure and function. ☐ PubMed (www.ncbi.nlm.nih.gov/entrez/) is a service of the U.S. National Library of Medicine (www.nlm.nih.gov/) that includes millions of citations science journals. If a scientist has not published a paper that appears in that database, he or she cannot make scientific claims.
Measurable Claims and Benefits?	3. What are the specific benefits claimed for using this program? 4. Does the program tell me what part of my brain or which cognitive skill I am exercising, and is there an independent assessment to measure my progress? 5. Is it a structured program with guidance on how many hours per week and days per week to use it?	☐ Some programs describe the benefits so vaguely that it is impossible to tell if they will have any measurable results. ☐ Brain exercise is not a magic pill. You have to do the exercises in order to benefit, so you need clarity on the effort required. ☐ Simply by practicing something, we get better at it over time. The question is whether the improvement experienced in the program will transfer into real life. For that to happen we need assessments that are distinct from the exercises themselves.
Ensures Cross-Training?	6. Do the exercises vary and teach me something new?	☐ The only way to exercise important parts of our brain is by tackling novel challenges. ☐ In the case of brain fitness, "Use it or Lose it" applies to all the different functional areas of our brain and the skills we need those areas to perform.
Is it Exercise – or Entertainment?	7. Does the program challenge and motivate me, or does it feel like it would become easy once I learned it?	☐ Just as we need to work out our arm and leg muscles with increasing weight to develop them, good brain exercise requires increasing difficulty as well.
Good Fit for Me?	8. Does the program fit my personal goals? 9. Does the program fit my lifestyle? 10. Am I ready and willing to do the program, or would it be too stressful?	☐ Each individual has different goals/needs when it comes to brain health. For example, some want to manage anxiety, others to improve short-term memory, listen better, improve concentration levels, or reduce the probability of developing problems such as Alzheimer's over the long term. ☐ Some brain exercise programs have great short-term results but are very intense - requiring up to 5 hours a week. Others may not have such clear short-term benefits, but may require a shorter time commitment. ☐ Excess stress reduces, or may even inhibit, neurogenesis (the creation of new neurons). So, it is important to make sure not to do things that stress us in unhealthy ways.

SHARPBRAINS

BRAIN FITNESS FOR ALL

www.sharpbrains.com

The Science Behind Brain Training

- Review evidence for traditional cognitive rehabilitation
  - Keith Cicerone
- Understand neuroplasticity as it relates to rehabilitation
  - Michael Merzenich; IMPACT study
- Investigate support for specific programs and disorder types
  - Start with company websites
- Know the limitations of brain training
  - Nature study

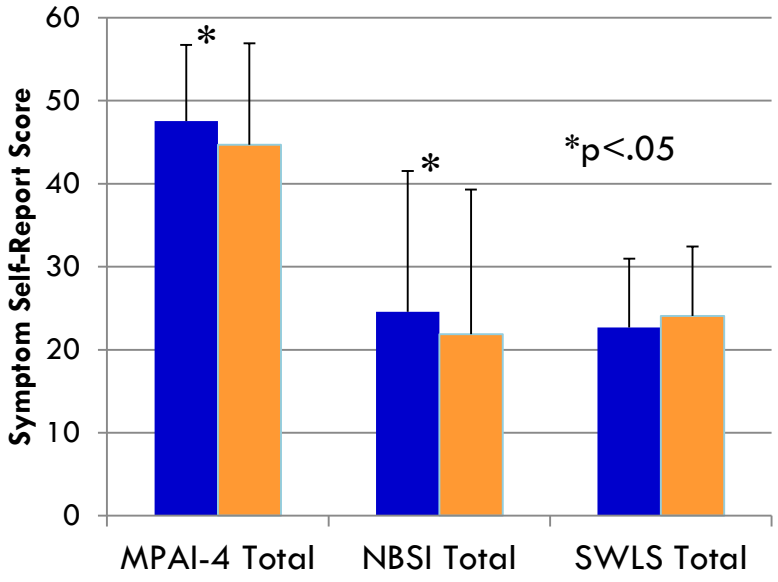
Retrospective Study

Purpose: Determine the effectiveness of the BFC program and products through patient self-report questionnaires

Method: Chart review of the first 96 patients to participate in the BFC

Participants and Procedures: 29 patients who completed 3 questionnaires of self-reported symptom change before and after BFC participation in an average of 29 (range = 3 – 137) visits

Results: Statistically significant reduction in symptom severity based on MPAI and NBSI total scores (*p<.05). There was no significant difference in the SWL score.



Caveat: Population was highly heterogeneous and procedures varied widely.

Other Research at WRNMMC

- *Prospective, Randomized Control Study*
  - Efficacy and feasibility of Dakim and Posit Science programs as adjunct to cognitive rehab.

CNRM
CENTER FOR NEUROSCIENCE AND REGENERATIVE MEDICINE

- *Retrospective/Prospective Clinical Database*
  - To include all past 300+ patients, current and future for large clinical database

Congressionally Directed Medical Research Programs
CDMRP
Department of Defense

- *CDMRP Grant BRAVE Trial*
  - 3 year, multi-site for new program being developed by PositScience

- *mPOD Study for mTBI Patients*
  - Compare neuro and biofeedback in a pod environment vs. outside the pod environment

Benefits and Limitations in the Rehabilitation Setting

Limitations

- Research limited on efficacy and generalization
- Blanket approach for various disordered populations
- Could lead to less monitoring
- Perceptions that the program “is enough”

Benefits

- Dosing recommendations
- Patient engagement with excellent graphics, game atmosphere
- Discharge benefits for maintenance and telerehabilitation
- Allows drill work for therapists to focus on functional activities
- May help increase efficacy of tx while decreasing cost

Take-Away Tips

- Maintain Flexibility
  - Technology changes, new programs are developed
  - Rehab is Rehab
- Listen to your patients
  - Understand their unique goals and needs
  - Record their feedback
- Maintain database
  - Streamline notes in template form
  - Be able to answer questions about your program quickly and accurately
- Remember you are part of a team
  - Usually an adjunct and not at stand-alone service
  - Your patient's success depends on your collaboration with other health-care professionals

Ask good questions but don't be left behind

Does it transfer? Is it functional? Not enough outcome data!

Not a gold standard. Lots of data coming, don't be left behind!

References

Brehmer Y, Westerberg H, and Backman L. Working-memory training in younger and older adults: training gains, transfer, and maintenance. *Frontiers in Human Neuroscience*. 2012; 6(63): 1-7.

Cicerone KD, Langenbahn DM, Braden C, Malec JF, Kalmar, K, Fraas M, Felicetti T, Laatsch L, Harley JP, Berqquist T, Azulay J, Cantor J, & Ashman T. Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008, *Archives of Physical Medicine and Rehabilitation,* 92:4 (2011), 519-530.

Diener E, Emmons RA, Larson RJ, and Grillin S. The Satisfaction with Life Scale. *Journal of Personality Assessment*. 1985; 49:171-75.

Johnson DR, Vincent AS, Johnson AE, Gilliland K, Schlegel RE. Reliability and construct validity of the Automated Neuropsychological Assessment Metrics (ANAM) mood scale. *Archives of Clinical Neuropsychology*. 2008; 23(1): 73-85.

Katsnelson A. No gain from brain training: Computerized mental workouts don't boost mental skills, study claims. *Nature*. 2010; 464: 1111.

Malec, JF, Kragness M, Evans R, Kent A, and Lezak MD. Further psychometric evaluation and revision of the Mayo-Portland Adaptability Inventory in a National Sample. *Journal of Head Trauma and Rehabilitation*. 2003;18(6): 479-492.

Meterko M, Baker E, Stolzmann KL, Hendricks AM, Cicerone KD, and Lew HL. Psychometric assessment of the Neurobehavioral Symptom Inventory-22: the structure of persistent postconcussive symptoms following deployment-related mild traumatic brain injury among veterans. *Journal of Head Trauma and Rehabilitation*. (2012); 20(1): 55-62.

Smith GE, Housen P, Yaffe K, Ruff R, Kennison RF, Mahncke HW, Zelinski M. A cognitive training program based on principles of brain plasticity: results from the improvement in memory with plasticity-based adaptive cognitive training (IMPACT) study. *Journal of the American Geriatrics Society*. 2009 Apr; 57(4): 594-603.

Sullivan KW, Quinn JE, Pramuka M, Sharkey LA, French LM. Outcomes from a pilot study using computer-based rehabilitative tools in a military population. *Studies in Health Technology and Informatics*. 2012; 181:71-77.

Willis SL, Tennstedt SL, Marsiske M, Ball K, Elias J, Koepke KM, Morris JN, Rebok GW, Unverzagt FW, Stoddard AM, Wright E, for the ACTIVE Study Group. Long-term effects of cognitive training on everyday functional outcomes in older adults. *JAMA*. 2006; 296: 2805–2814.

Studies In Clinical Indications Show Effects Across Broad Range of Cognitive Impairments

- Schizophrenia (cognitive impairment)
  - Fisher (2009) *Am. J. Psych.*: 55 patients, 2 arm RCT showed significant global cognitive function improvement
    - Further assessments showed fMRI changes, serum growth factor changes, and further improvement with longer training duration
  - Keefe (2012) *J. Clin. Psych.*: 53 patients, 2 arm RCT showed significant global cognitive function improvement
- HIV Associated Neurocognitive Disorder (HAND)
  - Vance (2012) *J. Assoc. Nurses AIDS Care*: 46 patients, 2 arm RCT showed significant speed improvement and significant instrumental activities of daily living improvement
- Cancer/Chemotherapy Associated Cognitive Impairment ("Chemobrain")
  - Von Ah (2012) *Breast Cancer Research & Treatment*: 82 patients, 3 arm RCT showed significant speed, memory, and quality of life improvements
- Mild Cognitive Impairment (pre-Alzheimer's)
  - Barnes (2009) *Alz. Dis. Assoc. Dis.*: 47 patients, 2 arm RCT showed trend towards improvement in memory
- Traumatic Brain Injury
  - Lebowitz (2009) *Archives of Physical Medicine and Rehabilitation*: 8 patients, single arm study showed improvement in in cognitive speed and and reduced cognitive failures

Websites

- Dakim Brain Fitness
  - www.dakim.com
- Posit Science
  - www.positscience.com
- Lumosity
  - www.lumosity.com
- Cogmed
  - www.cogmed.com
- mPOD
  - www.hapiny.com

QUESTIONS?