COMPUTER-BASED BRAIN FITNESS PROGRAMS FOR TRAUMATIC BRAIN INJURY REHABILITATION

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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.
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
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 OEF in 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

**TBI Severity**

- Mild 141
- Moderate 32
- Severe 19
- Penetrating 15
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
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:**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Strongly Disagree</td>
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**I thought the time commitment to the program was realistic and easy to accomplish:**

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

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**I would like to have this computer program at home:**

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**I am glad I participated in this program:**

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**I would recommend this computer program to other service members:**

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<tr>
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**Access to educational materials and a brain injury specialist was helpful:**

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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*

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* Indicates patient name
Patient Satisfaction
Per Program (33 Dakim, 28 Posit, 5 Both)

Self-Perceived Areas of Improvement
Total

Self-Perceived Areas of Improvement
By Program

Number of Patients

Memory
Concentration/Attention
Math
Decision Making
Real-World Tasks
Listening
Visual Tasks
Vocabulary

Dakim
Posit
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

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dakim Brain Fitness</strong></td>
<td>• Cross-Trainer</td>
</tr>
<tr>
<td><strong>Posit Science - Classic</strong></td>
<td>• Auditory Processing</td>
</tr>
<tr>
<td><strong>Posit Science - Insight</strong></td>
<td>• Visual Processing</td>
</tr>
<tr>
<td><strong>Posit Science - BrainHQ</strong></td>
<td>• Auditory, Visual, and Executive Functioning</td>
</tr>
<tr>
<td><strong>Lumosity</strong></td>
<td>• Web-Based, Cross-Trainer</td>
</tr>
<tr>
<td><strong>Cogmed</strong></td>
<td>• Working Memory</td>
</tr>
<tr>
<td>mPOD/OVEI</td>
<td>• Neuro and biofeedback</td>
</tr>
<tr>
<td><strong>Nintendo DS</strong></td>
<td>• Brain Age, Brain Age II</td>
</tr>
<tr>
<td><strong>Mobile Applications</strong></td>
<td>• Training on the go</td>
</tr>
</tbody>
</table>
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)
124 Types of Games
Dakim Exercises Based On Standardized Neurological Tests

**Domain: Short-Term Memory**

- **Standardized Neurological Test/Exercise**
  - Wechsler Memory Scale
  - Digits Forward Test
  - Point Digit Span
  - Letter Span
  - Recurring Figures Test
  - Picture Scanning of Behavioral Inattention Test
  - Wechsler Memory Scale - III Family Pictures
  - Wechsler Memory Scale - III
  - Hopkins Verbal Learning Test-Revised
  - Four Unrelated Words
  - Benson Bedside Memory Test
  - Auditory-Verbal Learning Test
  - Wechsler Memory Scale, Logical Memory
  - Memory Assessment Scales

**Exercise Description**

Recall a sequence of numbers

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.

Cards containing geometric or irregular nonsense figures are shown, with some repeating. Subject is asked to indicate which designs were seen previously.

Look at series of pictures carefully and both name and point out the "major items" in the pictures.

Recall words after incremental time delays

Examiner reads stories, asking subject for an immediate free recall of facts

**Dakim BrainFitness Exercise**

- Memory Mambo
  - Word Wager
  - My Favorite Things
  - What's Unique
  - Odd Couples
  - Famous People Little Known Facts
  - Picture Pairs
  - Make a Story
  - Mazie's Face Finder
  - Book Briefs
  - Keep Your Eyes Open
  - News Flash
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

- **TELL US APART**
  Practices distinguishing similar sounds

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

- **SOUND REPLAY**
  Practices remembering information in order

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

- **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

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

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

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

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

MASTER GARDENER
Works out your working memory so you can recall visual details
BrainHQ Dashboard
Progress and Friends
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
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
  - Flexibility
  - Spatial Memory
  - Short-Term Memory
  - Processing speed
  - 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
- 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
• 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

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Pricing</th>
<th>Product Mode and Target Age</th>
<th>Brain Function</th>
<th>Recommended dosing by program</th>
</tr>
</thead>
<tbody>
<tr>
<td>(m) Power by Dakim</td>
<td>$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</td>
<td>Software program or complete system, ages 60 and older</td>
<td>Variety</td>
<td>40-60 minutes 3-5 times a week</td>
</tr>
<tr>
<td>Brain Fitness Classic by Posit Science</td>
<td>$197 for Auditory Software</td>
<td>Software Program, for adults</td>
<td>Auditory processing</td>
<td>40-60 minutes 3-5 times a week /6 -8 weeks</td>
</tr>
<tr>
<td>InSight with Cortex by Posit Science</td>
<td>$197 for Visual Software</td>
<td>Software Program, for adults</td>
<td>Visual processing</td>
<td>40-60 minutes, 3-5 times a week</td>
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# Brain Training Software

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

<table>
<thead>
<tr>
<th>Questions to Consider</th>
<th>Why</th>
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<tbody>
<tr>
<td><strong>Based on Scientific Research?</strong></td>
<td></td>
</tr>
<tr>
<td>1. Are there scientific (neuropsychological) and scientific advisory boards behind the program?</td>
<td>□ Neuroscientists are neuroscientists with specialized knowledge in measuring and understanding human cognition and brain structure and function.</td>
</tr>
<tr>
<td>2. Are there published, peer-reviewed scientiﬁc papers written by these scientists? How many?</td>
<td>□ Scientists have not published a paper that appears in that database, so they cannot make scientiﬁc claims.</td>
</tr>
<tr>
<td><strong>Measurable Claims and Benefits?</strong></td>
<td></td>
</tr>
<tr>
<td>3. What are the speciﬁc beneﬁts claimed for using this program?</td>
<td>□ Some programs describe the beneﬁts so vaguely that it is impossible to tell if they will have any measurable results.</td>
</tr>
<tr>
<td>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?</td>
<td>□ Brain exercise is not a magic pill. You have to do the exercises in order to beneﬁt, so you need clarity on the off-the-shelf results.</td>
</tr>
<tr>
<td>5. Is it a structured program with guidance on how many hours per week and days per week to use it?</td>
<td>□ Simply by practicing something, you get better at it over time. The question is whether the improvement experienced in the program will transfer into reality. For that to happen, we need assessments that are distinct from the exercises themselves.</td>
</tr>
<tr>
<td><strong>Ensures Cross-Training?</strong></td>
<td></td>
</tr>
<tr>
<td>6. Do the exercises vary and teach me something new?</td>
<td>□ The only way to exercise important parts of our brain is by tackling novel challenges.</td>
</tr>
<tr>
<td><strong>Is it Exercise or Entertainment?</strong></td>
<td></td>
</tr>
<tr>
<td>7. Does the program challenge and motivate me, or does it feel like I would become easy once I learned it?</td>
<td>□ In the case of brain exercise, “use it or lose it” applies to the cognitive functional areas of our brain and the skills we need those areas to perform.</td>
</tr>
<tr>
<td><strong>Good Fit for Me?</strong></td>
<td></td>
</tr>
<tr>
<td>6. Does the program ﬁt my personal goals?</td>
<td>□ Just as we need to work out our arm and leg muscles with increasing weights to develop them, good brain exercise requires increasing difﬁculty as well.</td>
</tr>
<tr>
<td>5. Does the program ﬁt my lifestyle?</td>
<td></td>
</tr>
<tr>
<td>6. Am I really and willing to do the program, or would the stress tax me?</td>
<td></td>
</tr>
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**SharpBrains**

Brain Fitness for All
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
**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.

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

- **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


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


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 cognitive speed and reduced cognitive failures
Websites

- Dakim Brain Fitness
  - [www.dakim.com](http://www.dakim.com)
- Posit Science
  - [www.positscience.com](http://www.positscience.com)
- Lumosity
  - [www.lumosity.com](http://www.lumosity.com)
- Cogmed
  - [www.cogmed.com](http://www.cogmed.com)
- mPOD
  - [www.hapiny.com](http://www.hapiny.com)
QUESTIONS?