

Computer-based Cognitive Training in a Military Population



Kate Sullivan, M.S., CCC-SLP
Director, Brain Fitness Center
Defense and Veterans Brain Injury Center
Traumatic Brain Injury Service
Walter Reed National Military Medical Center

Wendy A. Law, Ph.D.
Clinical Neuropsychologist
Traumatic Brain Injury Service
Walter Reed National Military Medical Center

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Goals

- Describe the need, development over time, and changing demographics of patients participating in a computer-based cognitive training center embedded in a Military Treatment Facility.
- Lessons learned from initial implementation and complications surrounding research efforts will be highlighted.
- Controversies and efficacy concerns related to computer-based cognitive training will be briefly reviewed.
- Preliminary results of patients completing a minimally expected intensity training experience at the BFC at Walter Reed National Military Medical Center will be presented.

Poll

What is the audience's experience with computer (software or web-based) brain-training programs released into the market in the last 10 years?

- A. No experience with recent brain-training programs on the market
- B. Personal knowledge or experience but have not used or recommended the use of these programs with my patient population
- C. Have experience using and recommending programs with my patient population, but on a limited basis
- D. Use and/or recommend brain-training programs on a regular basis for my patients

Poll

Which of the following are professional criticisms regarding computer (software or web-based) brain-training programs? (select all that apply)

- A. Not theoretically-grounded
- B. Inability to reach wide-ranging patient populations
- C. Too complicated for most patients
- D. Professional involvement is not necessary

Looking for novel rehabilitation approaches for our unique 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



Looking for a novel approach – why computers?

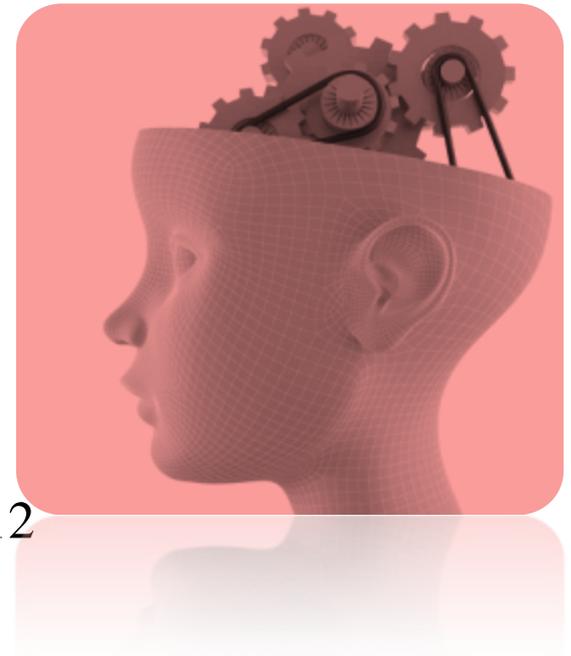
- Growing literature in neuroplasticity
- Allows more cognitive training as an adjunct to functional rehab
- Therapeutic “homework” that can be intensive and monitored
- Provides adaptability, intensity, and engagement
- Maintenance once discharged with transition home with software
- Commercially available



The Brain Fitness Center

Walter Reed National Military Medical Center, est. 2008

- Contains a library of brain-training programs
- Provides adjunct cognitive rehabilitation services; not a stand-alone therapeutic approach
- Established with clinical, educational, and research goals
- Expanded to Fort Belvoir Community Hospital in 2012
- One completed and three current research protocols
- Continue to explore if this is the appropriate population or setting



Outcome Measures

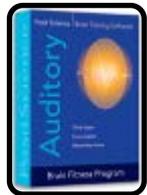
- Initial intake, approx. every 8 weeks, and then at completion of BFC participation:
 - Automated Neuropsychological Assessment Metrics (ANAM)
 - Mayo-Portland Adaptability Inventory-4 (MPAI-4)
 - Neurobehavioral Symptom Inventory (NBSI)
 - Satisfaction with Life Scale (SWLS)
 - Post-Traumatic Stress Disorder Checklist – Civilian Version (PCL-C)
 - Headache Impact Test – 6 (HIT-6)
 - Patient Satisfaction Survey – *discharge only*
- Daily before and after sheet at each visit to the BFC
 - Pain; Restfulness; Self Esteem; Insight into progress

Programs available in the WRNMMC BFC



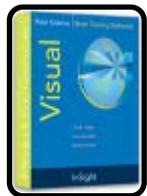
Dakim Brain Fitness

- Cross-Trainer



Posit Science - Classic

- Auditory Processing



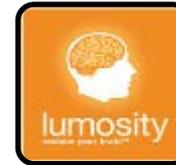
Posit Science - Insight

- Visual Processing



Posit Science - Brainhq

- Auditory, Visual, and Executive Functioning



Lumosity

- Web-Based, Cross-Trainer



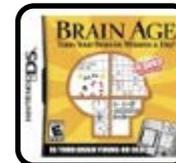
Cogmed

- Working Memory



mPod

- Neuro/Biofeedback



Nintendo DS

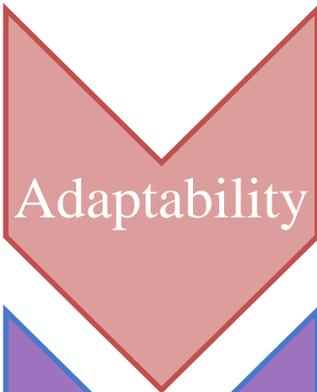
- Brain Age, Cross-Trainer



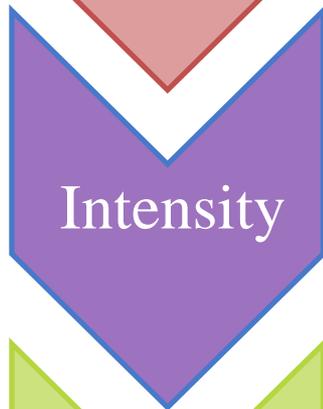
Mobile Applications

- Training on the go

Considerations for Selection



- Dynamic; self-adjusts
- Hold participants at an appropriately challenging yet not a frustrating level



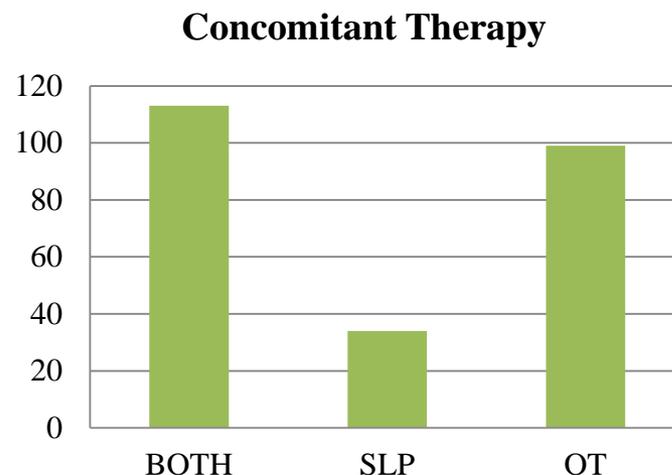
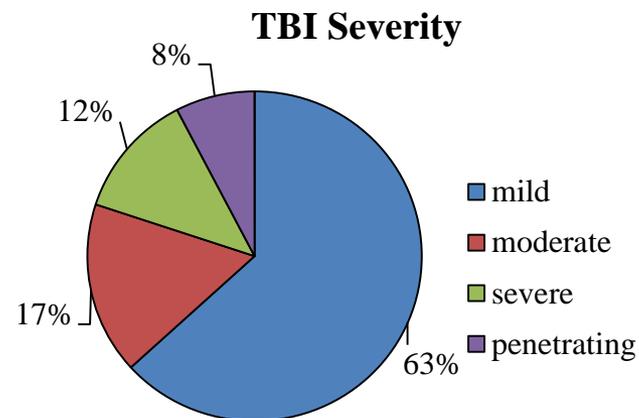
- Significant repetition to drive real change
- Process based to impact plasticity



- Some means of feedback and rewards
- Entertainment value to increase compliance and sustainability

BFC Patient Population

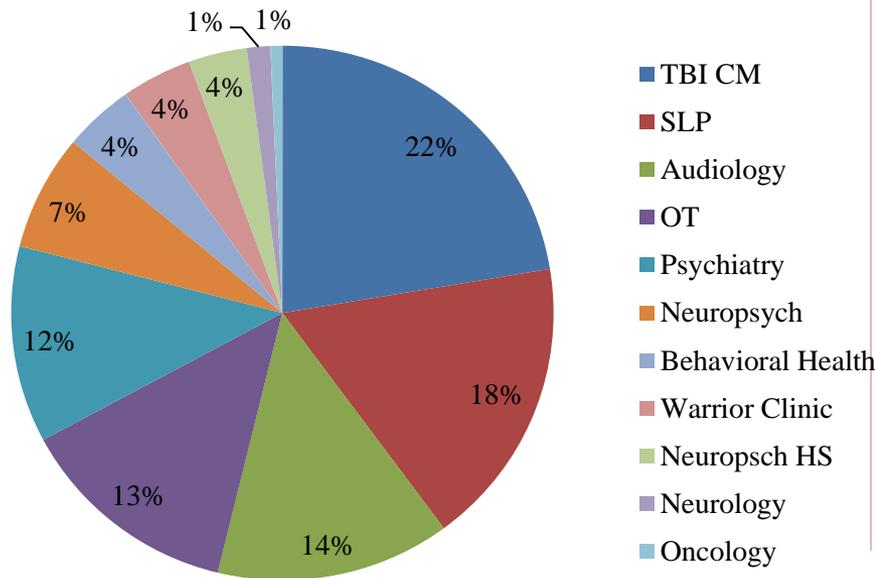
- 438 total patients at WRNMMC
- Diagnosis:
 - 261 TBI
 - 134 Other (CVA, PTSD, ADHD, Aneurysm, Chemofog, etc.)
- Average age 35; 84% male
- Majority United States Army, Active Duty
- 50% of pts seen >1 year TPO
- Pt visits per month (2013): 187
- Average 23.4 sessions
- Average stay 96.0 days
- 62% currently in SLP, OT or both



Does computer-based “brain training” help?

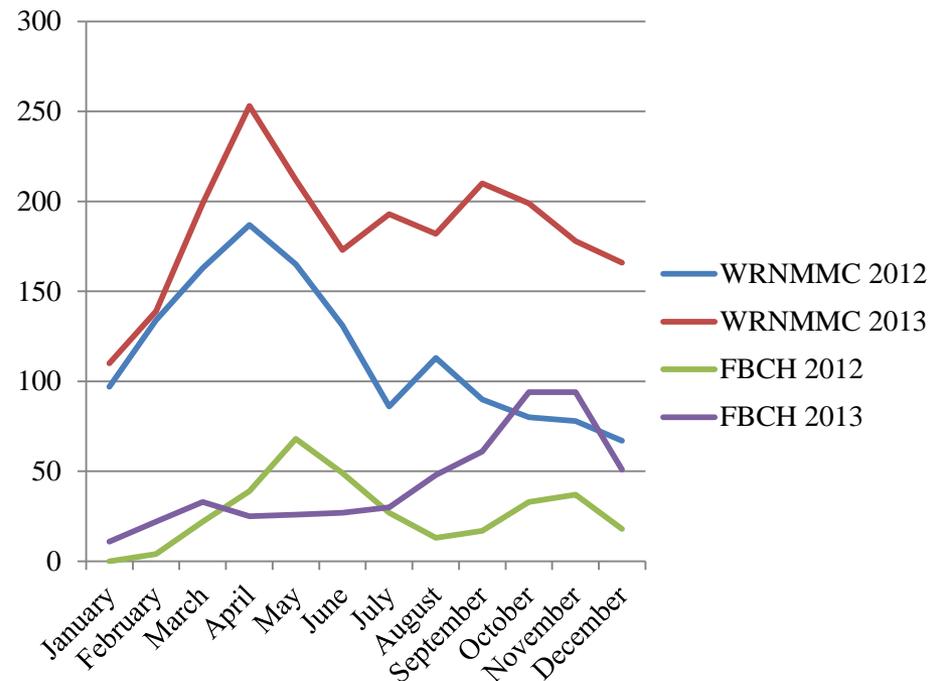
A resource for providers:

Referrals 2013



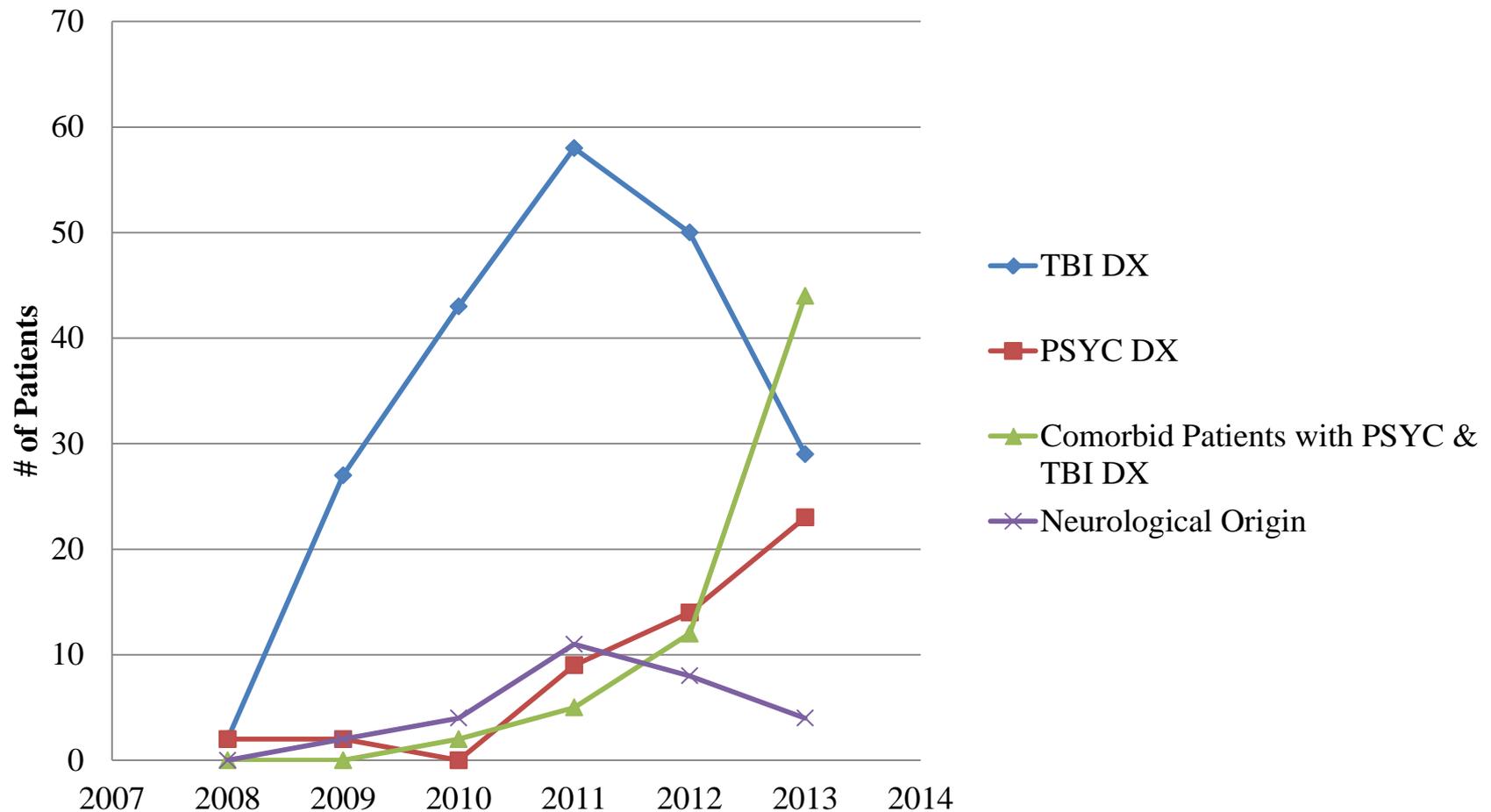
A resource for patients:

Patient Visits

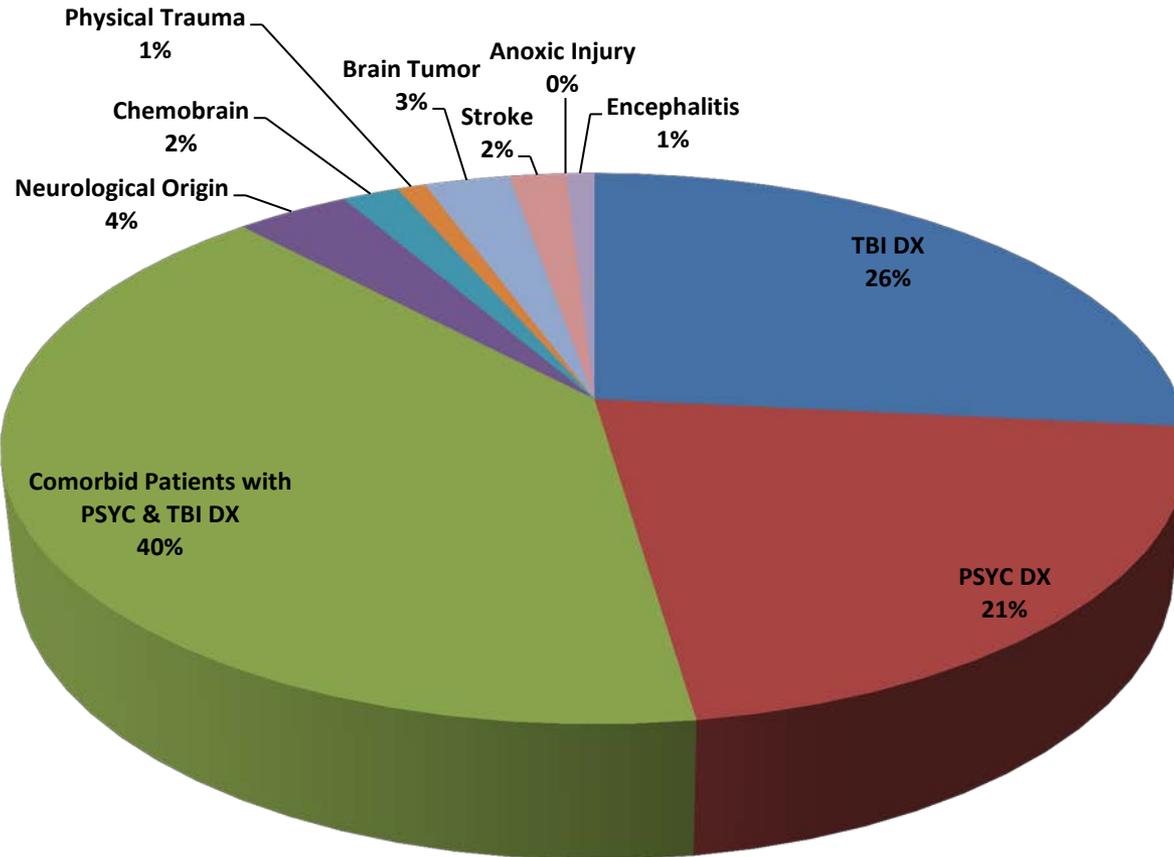


Novel approach, as well as a novel – and changing - population

Brain Fitness Center Patient Visits



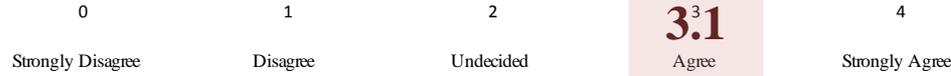
Demographics



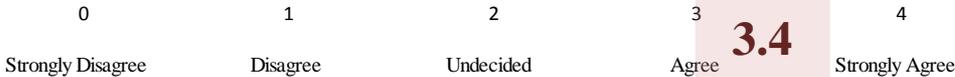
BFC DX % Breakdown for 2013

Brain Fitness Center Patient Satisfaction Survey

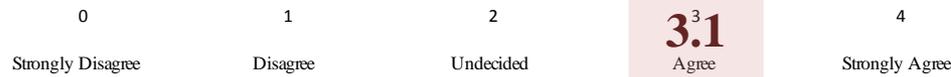
This computer program helped my recovery process:



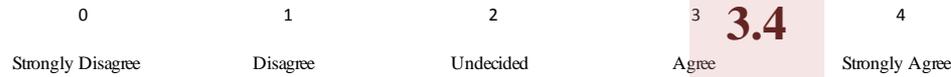
I thought the time commitment to the program was realistic and easy to accomplish:



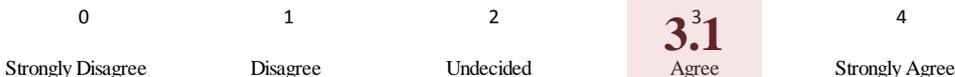
I found the content of the computer program to be fun and engaging:



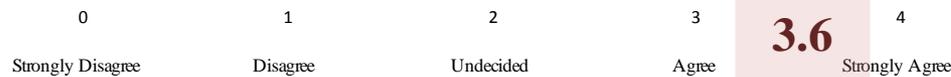
I found the content of the computer program to be appropriately challenging:



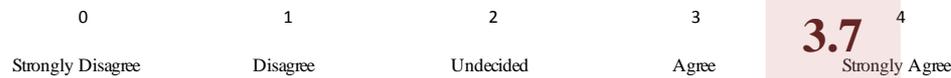
I would like to have this computer program at home:



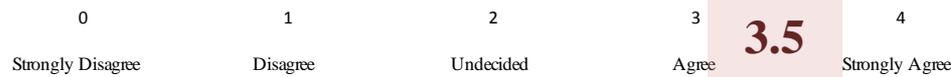
I am glad I participated in this program:



I would recommend this computer program to other service members:



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



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



Results of the first 101 completed surveys:

Above: Number of participants, out of 101, 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*

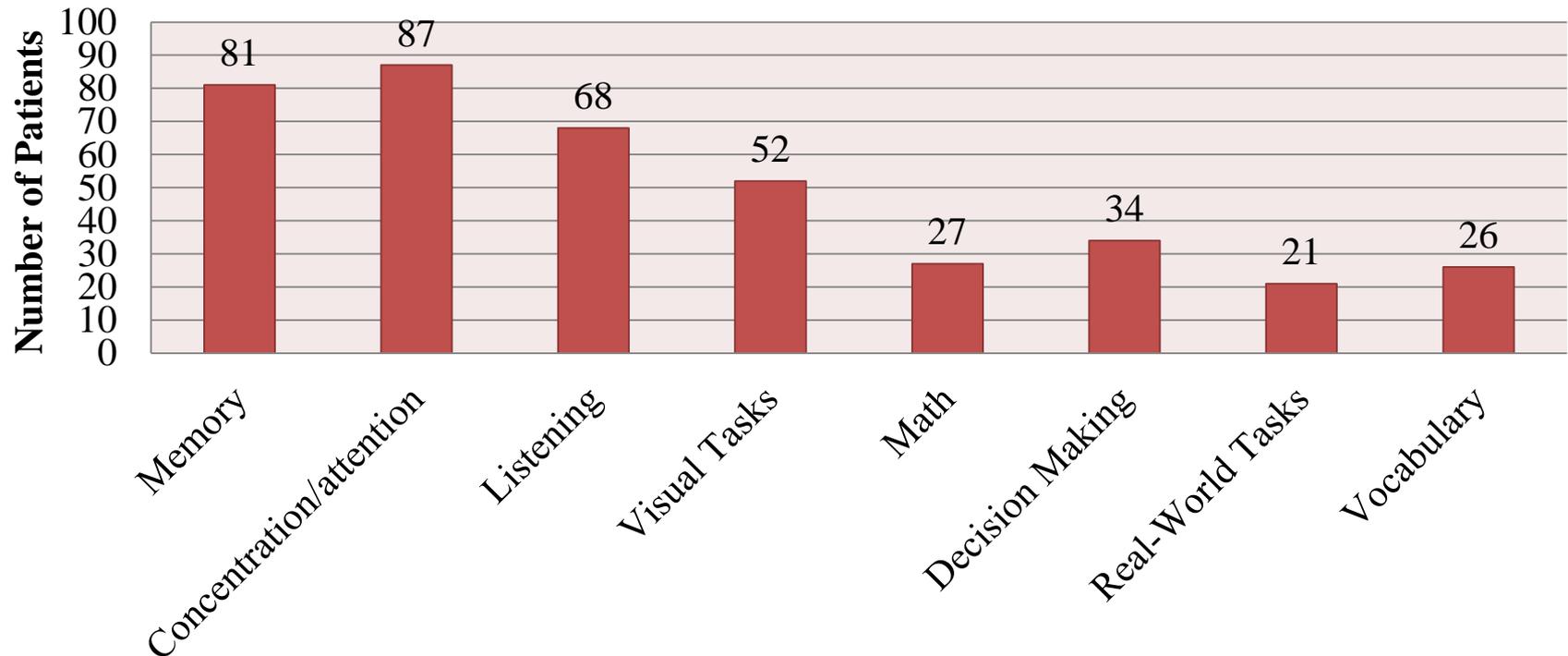
“Great program helped me in life/work environments... Recommend to everyone. This is good and very helpful.”
- John Smith*

“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

Self-Perceived Areas of Improvement



Benefits and Limitation of adding brain-training programs in a military treatment facility

Limitations

- Less Monitoring
- Perception it is “enough”
- Blanket approach?
- Pts are not home
- Pts are not stable
 - Physically
 - Psychologically
 - Socially
- Low compliance

Benefits

- Focus on drills
- Mobile
- Low-cost
- Patient engagement
- Independent
- Novel patients, novel approach
- Intro to healthy brain habits
- Maintenance

Clinical Challenges and Proposed Solutions

Current Clinical Considerations	Proposed Solution	Anticipated Outcome
Less Monitoring	Clinician supervision	Increase in BFC-related therapeutic goals
Perception it is “enough”	Provider education	Increased awareness of limitations of the program
Blanket Approach	Provider education on specific computer-based programs	Referrals based on cognitive complaint with recommendations
Patients are not home	Allow flexibility but encourage routine and regular visits	Provide the groundwork of healthy brain habits
Patients are not stable	Basic introductory information and demos; include caregivers	Establish more educated consumers
Low compliance, especially early	Offer incentives	Increased long-term program use

A randomized, controlled pilot study looking at the effectiveness and feasibility of novel rehabilitation approaches for Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) patients with persistent complaints of cognitive dysfunction following a traumatic brain injury

Principal Investigator: Louis M. French, PsyD

Site Principal Investigator (Fort Belvoir): Heechin Chae, M.D.

Co-Investigators:

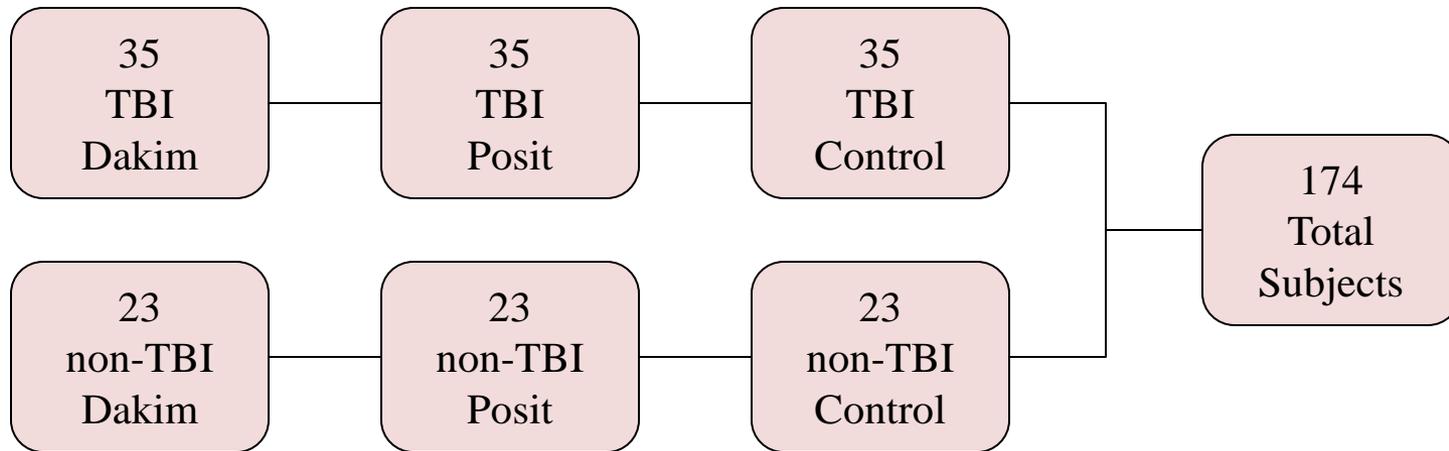
- Katherine Sullivan, M.S., CCC-SLP
 - Michael Pramuka, Ph.D.
 - Julia Quinn, B.A.

Study Objectives

- **Specific Objective (Aim) 1: Measure and compare the subject's self-perception of symptoms as measured by the:**
 - Mayo Portland Adaptability Index - 4 (MPAI - 4)
 - Neurobehavioral Symptom Inventory (NBSI)
 - Satisfaction with Life Survey (SWL)
- **Specific Objective (Aim) 2: Measure and compare aspects of cognitive improvement between the two programs and control group using the:**
 - Automated Neuropsychological Metrics (ANAM)
- **Specific Objective (Aim) 3: Measure and compare the subject's satisfaction and compliance between the two programs and control group using a:**
 - Self-Report Form and Attendance Database

Study Design and Methods

Patients are randomly assigned to one of three groups

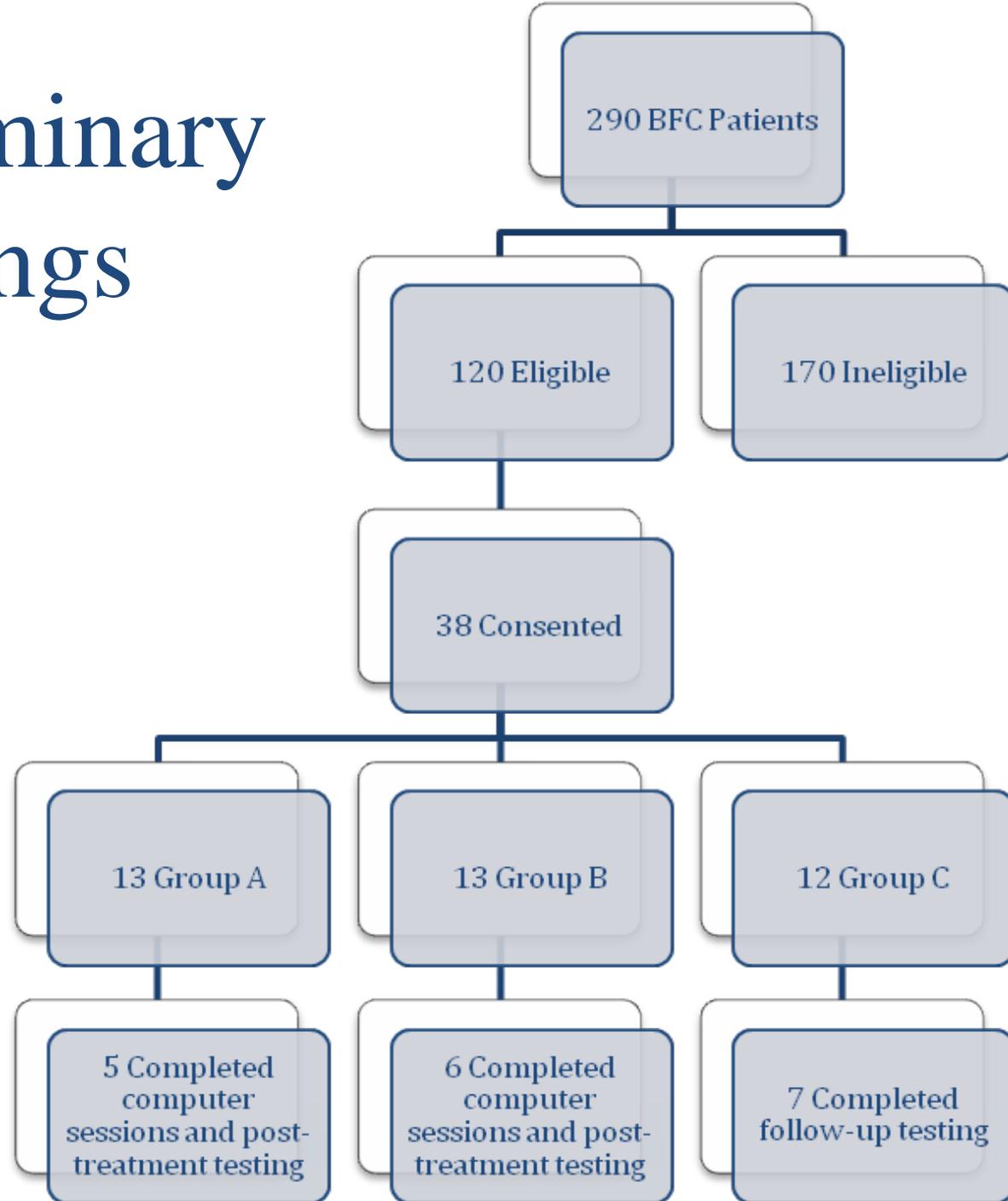


Subjects assigned to treatment groups are required to complete computer sessions 5x/week for 6 week

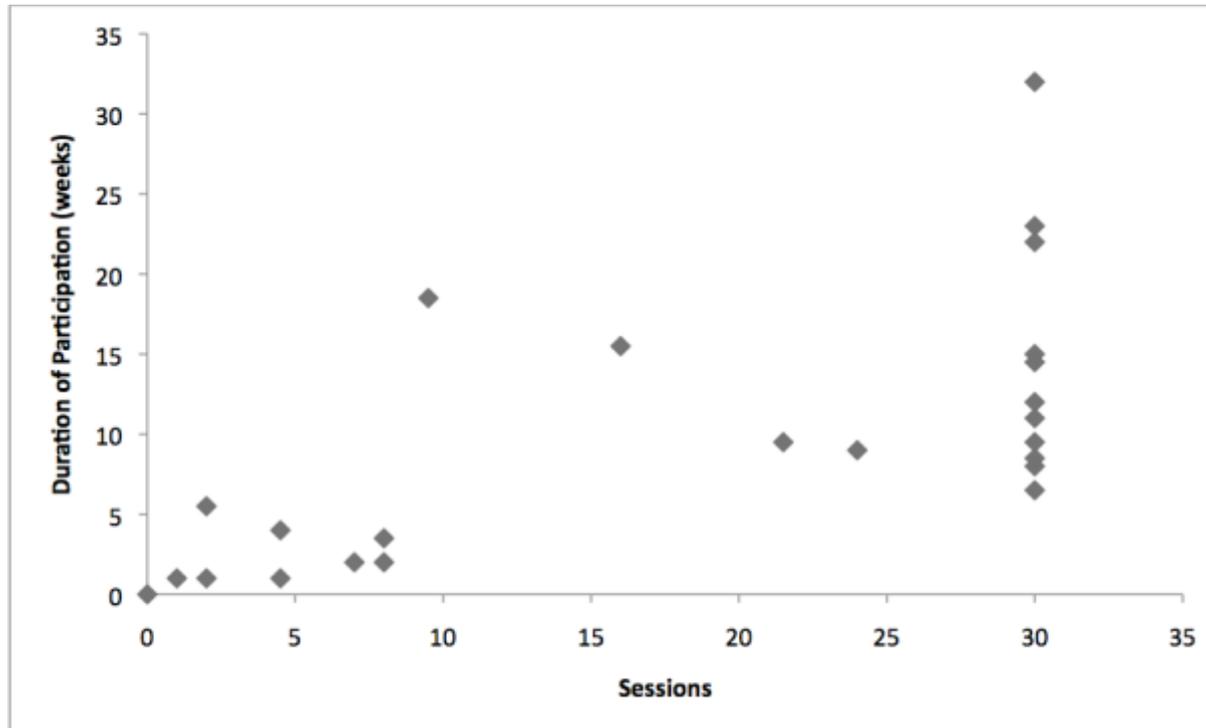
Outcome measures are administered pre-training, post-training, and at 12 months

Preliminary Findings

Non-Published



Compliance

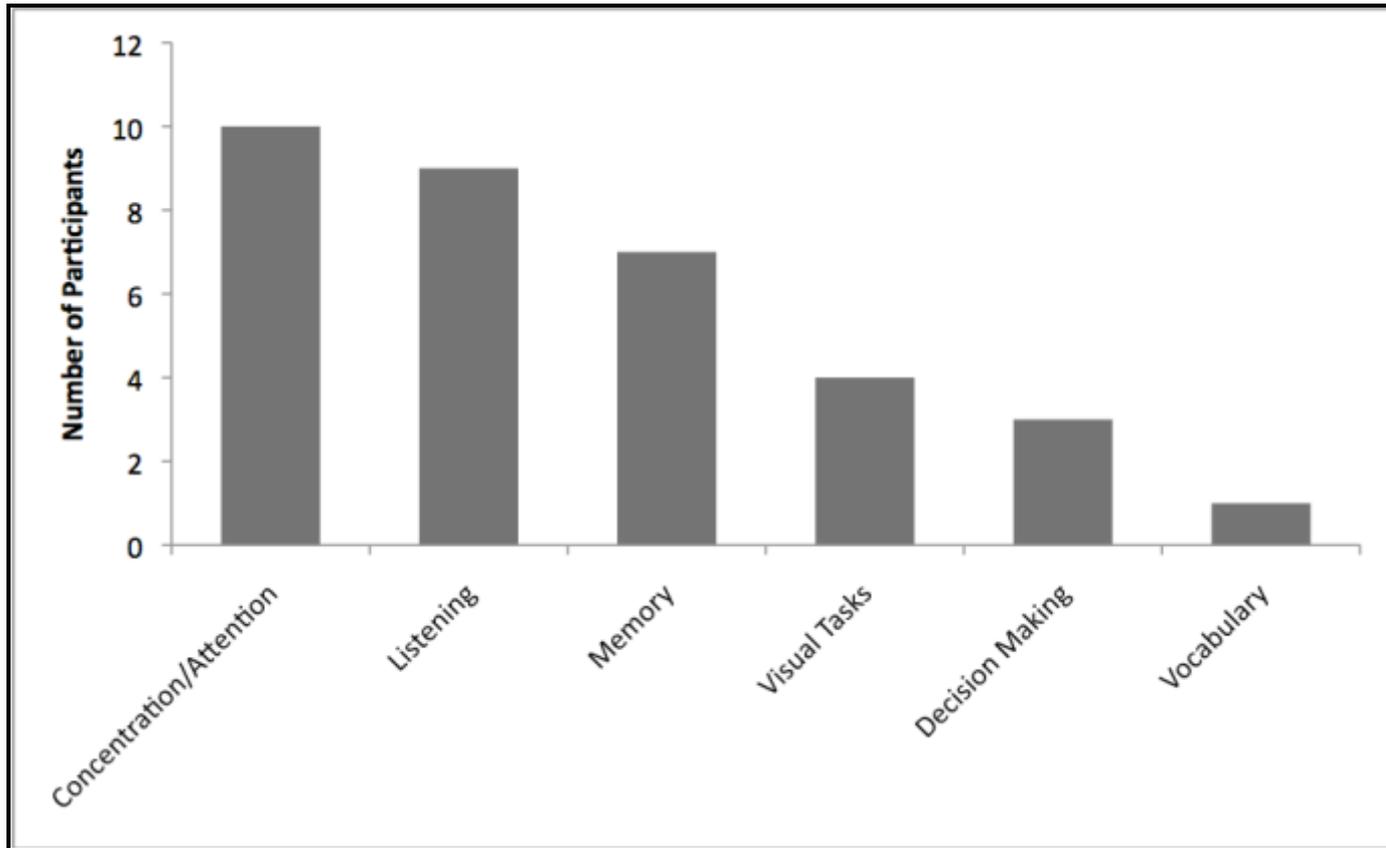


Number of sessions completed and the duration of participation for each research participant in Groups A and B (N=26). There are two data points at (0,0) and (30, 8). Study design intended 30 sessions in 6 weeks.

Satisfaction

Satisfaction Form Question	0-1 Disagree to Strongly Disagree	2 Neutral	3-4 Agree to Strongly Agree
This computer program helped my recovery process	0	3	8
I thought the time commitment to the program was realistic and easy to accomplish	0	0	11
I found the content of the computer program to be fun and engaging	1	1	9
I found the content of the computer program to be appropriately challenging	0	1	10
I would like to have this computer program at home	1	1	9
I am glad I participated in this program	0	0	11
I would recommend this computer program to other service members	0	1	10
Access to education materials and a brain injury specialist was helpful	0	1	10

Satisfaction



Self-perceived areas of improvement reported by participants on the Brain Fitness Center Patient Satisfaction Survey (N=11).

Research Challenges and Proposed Solutions

Current Study	Proposed Solution	Anticipated Change in Eligible Subjects
Recruitment through BFC referrals at two study sites	Add additional study-sites	45% increase per year, per site
Eligibility is restricted to combat-related symptoms	Inclusion of non-combat related symptoms	21.9%
Eligibility restricted to service members with <1 TBI within two years of consent	Inclusion of service members with up to three reported TBIs within two years of consent	4.7%
Sessions must be completed in the BFC	Web-based tools	12.3%
Daily session/5x per week	Flexible scheduling	11.2%
Group C (standard of care)	Placebo or waitlist control group	5.7%
No tangible incentive	Financial compensation for participation	Unknown

Research Challenges, Next Steps

- Explore our clinical patients with retrospective chart reviews; database
- Redesign our next randomized-controlled study based on our lessons learned



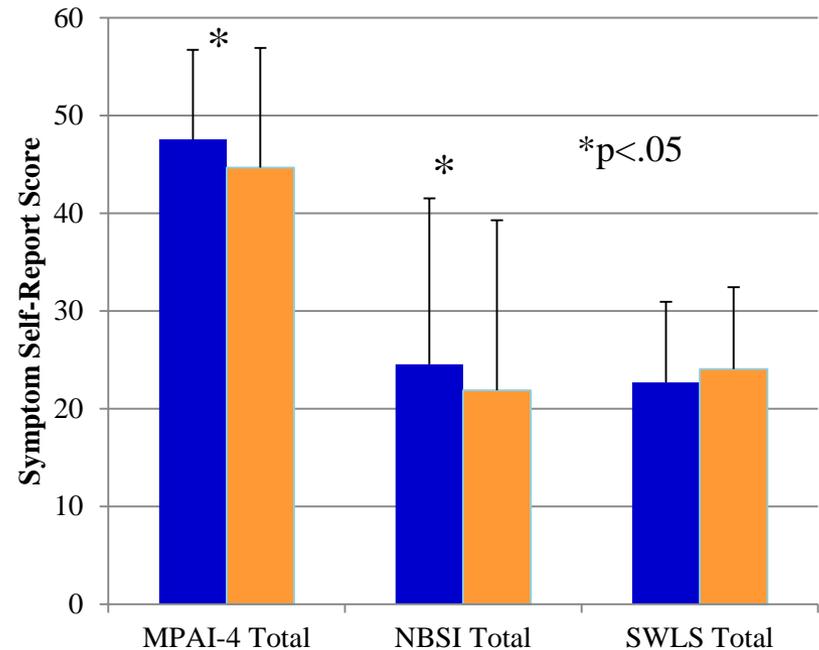
Retrospective Study

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

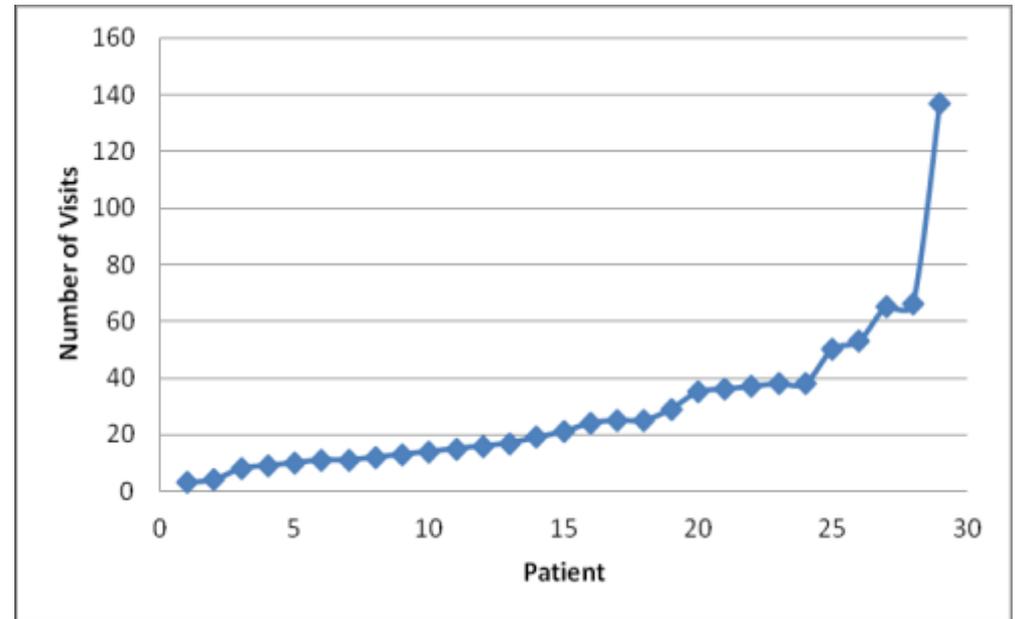
Results: Statistically significant reduction in symptom severity based on MPAI and NBSI total scores (* $p < .05$). There was no significant difference in the SWL score.



Caveat: Population was highly heterogeneous and procedures varied widely.

Patient Visits N = 29

- ❖ Figure 1 shows the distribution of patient visits to the BFC
- ❖ On average, patients completed computer sessions 29 times with a range of 3-137 visits (SD = 29.46, Median = 21)



Eight patients were also using an at-home cognitive program; data on how often they were completing these home-based sessions is not available

Discussion

- The reduction in symptom severity following BFC retraining suggests that improvements are generalized to a broad range of domains applicable to everyday functioning
- The three self-report questionnaires used in this study have high face validity for the Service Members
- Other factors beyond the brain-training intent of the computer program(s) may play a role in real or perceived self-betterment
- Limitations of this retrospective chart review
- This review was used as justification to capture a larger sample size which we are currently analyzing which may yield stronger results

Expanding our Understanding of Computer-Based Cognitive Rehabilitation in the Military Population – a Longitudinal Brain Fitness Center Database

Study Purpose and Objectives

- Develop a database that contains demographic information, clinical data, self-report questionnaires and objective cognitive assessments collected from the WRNMMC and FBCH Brain Fitness Centers.
- The data collected will provide the foundation for the development of hypothesis-driven protocols, and will ultimately advance our understanding of characteristics of treatment responders and non-responders, aspects of cognitive change, and self-perceived symptom change following Brain Fitness Center participation.

Exploratory Study: Cognitive efficiency and neurobehavioral symptoms of Military patients seeking BFC treatment

Goals and Methods

- Determine the relationship between baseline cognitive performance on the Automated Neuropsychological Assessment Metric 4-TBI battery (ANAM) and symptom severity on the Neurobehavioral Symptom Inventory (NBSI) in high and low symptom endorsers overall and within the mTBI and NOT mTBI subgroups
- A retrospective chart review was completed for BFC participants with ANAM baseline data (Nov 2008 – Feb 2011)
 - 97 patients had completed ANAM baseline assessments
 - ANAM and NBSI summary scores were used to determine relationships between objective performance and subjective symptoms (bivariate correlation and t-test analyses)

Patient Demographics (N=97)

- Majority male
- Age 20 - 56 (Mean = 33, Median = 31)
- Gender (90% male)
- Primarily Active Duty
- 74% of total sample had a dx of TBI
 - 66% of TBI = mild TBI (n45, 20% comorbid PTSD)
 - 34% of TBI = moderate, severe, penetrating

NOT mTBI subsample (n=52)

- TBI not mild (moderate, severe, penetrating)
- No TBI
 - Psychiatric – 33%
 - PTSD, MDD, phobia
 - Other Neurologic – 33%
 - Stroke, craniotomy, encephalitis, tumor, migraine
 - Physical – 33%
 - Physical trauma below neck, peripheral sensory deficits
- Unknown but not mTBI (n=3)

N=97 Total Sample

(n=45 mTBI) (n=52 NOT mTBI)

Primary measures

Mean/Median (range)

NBSI Total (max 88)

- N97 32/33 (0-74, SD18)
- n45 39/40 (0-74, SD16)
- n52 25/23 (0-63, SD17)

ANAM AVG TP STD

- N97 81/88 (41-113, SD18)
- n45 73/69 (41-103, SD19)
- n52 88/91 (48-113, SD14)

Correlations (N=97)

- NBSI Tot w/ ANAM TP (STD)
 - SRT1 TP STD -.511**
 - SRT2 TP STD -.417**
 - PRT TP STD -.378**
 - CDL TP STD -.401**
 - CDD TP STD -.380**
 - MTH TP STD -.320*
 - M2S TP STD -.356**
 - ANAM AVG TP STD -.491**

*p = .001
**p = .000

Correlations

N=45 (mTBI subsample)

- NBSI Tot w/ ANAM TP (STD)
 - SRT1 TP STD - .402**
 - SRT2 TP STD - .198
 - PRT TP STD -.220
 - CDL TP STD -.168
 - CDD TP STD -.096
 - MTH TP STD - .187
 - M2S TP STD -.325*
 - ANAM AVG TP STD -.276*

**p <.01

*p <.05

N=52 (NOT mTBI subsample)

- NBSI Tot w/ ANAM TP (STD)
 - SRT1 TP STD -.476**
 - SRT2 TP STD -.452**
 - PRT TP STD -.385**
 - CDL TP STD -.423**
 - CDD TP STD -.401**
 - MTH TP STD -.277*
 - M2S TP STD -.249*
 - ANAM AVG TP STD -.538**

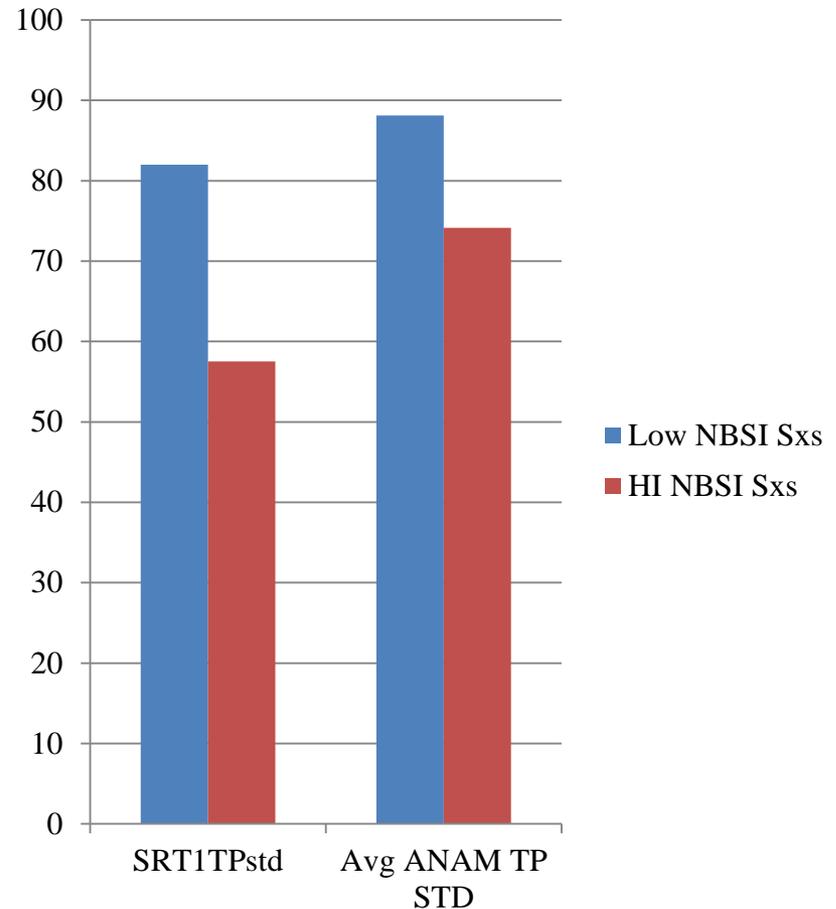
**p <.01

*p <.05

Results: NBSI Median Split (Low/High)

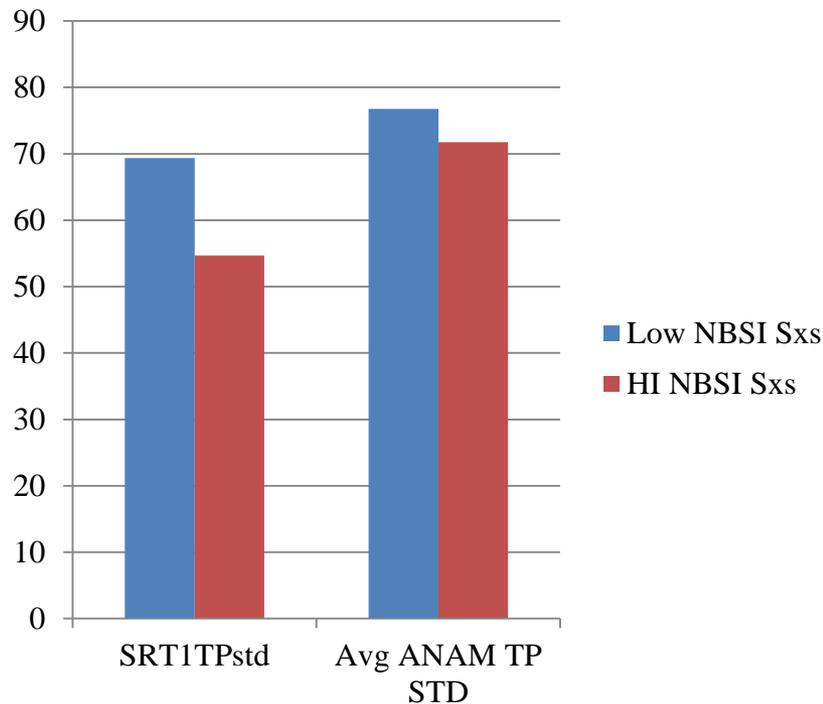
Total Sample N=97 (n50 L, n47 H)

- The Low symptom endorsement group had significantly more efficient initial simple RT performance efficiency and overall performance efficiency than High symptom endorsers (t-test: * $p < .01$)

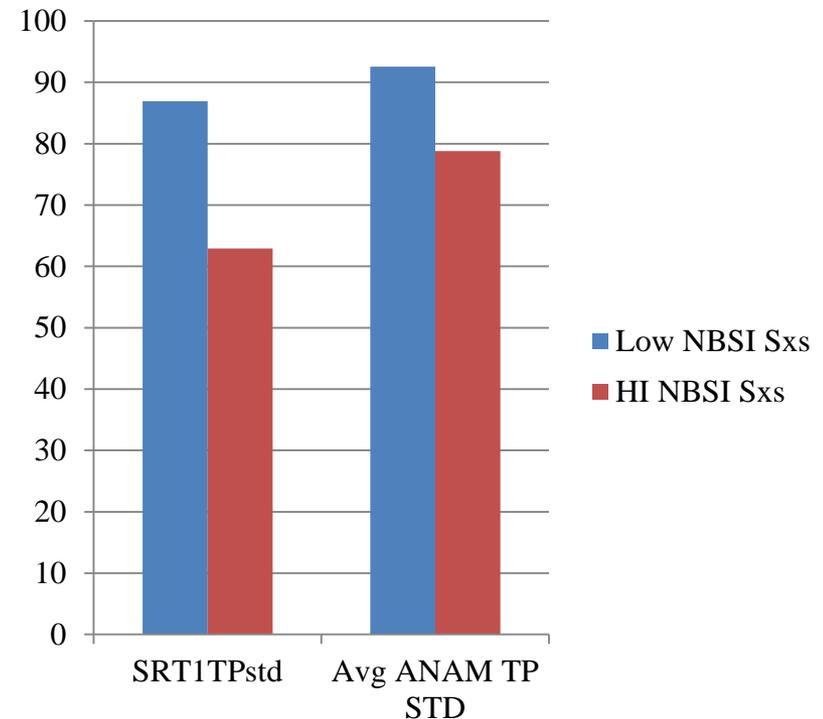


Results: NBSI Median Split (Low/High)

mTBI n=45 (n14 L, n31 H)
SRT1 TP p>.10, Avg TP >.10



NOT mTBI n= 52 (n36 L, n16 H)
SRT1 TP p<.01, Avg TP <.01



Conclusion/Discussion

- Within a Military patient population, subjectively reported neurobehavioral symptoms are associated with objective cognitive functioning in a general mixed clinical sample but are unclearly related in patients with mTBI/concussion as the primary diagnosis
- For mTBI patients reporting neurobehavioral symptoms, factors other than neurocognitive functioning play a role in symptom persistence
- Cognitive retraining outcomes related to such patient factors are unknown at this time and require further investigation. Patients without clear associations between objective performance and subjective symptoms may be less likely to benefit from cognitive retraining or may show improved cognitive functioning without reduced symptom report.
- Limitations of this retrospective chart review
- Future directions –Examine patient factors impacting outcome (e.g., premorbid risk factors/vulnerabilities, performance validity)

Performance Validity and symptom improvement

- **PRIOR FINDINGS**

- BFC Retrospective study results– Significantly improved Mayo and NBSI scores and suggested improvement in SWL in a mixed clinical sample following cognitive retraining exercises
- BFC Exploratory study results– ANAM performance efficiency is related to NBSI symptoms in a mixed clinical sample overall and in the subgroup that did not have mTBI but are not clearly related in the mTBI subgroup. Need to consider other factors

- **NEXT STEP**

- BFC Descriptive study – Examine the role of performance validity on symptom improvement following cognitive retraining exercises

Descriptive Study: Performance Validity and Symptom Improvement following Computerized Cognitive Retraining exercises

Goals and Methods

- Examine pre/post changes in MAYO, NBSI and SWL for the mixed clinical patient sample overall and in each of the two subsamples (mTBI and NOT mTBI) in relation to valid ANAM performances at both visits
- Completed ANAM assessments were reviewed to identify BFC participants that had pre/post ANAM testing results
 - 37 patients had completed two ANAM assessments (14 mTBI)
 - 18 patients had completed at least 12 BFC sessions (minimum accepted intensity) and had valid ANAM assessments at BOTH (pre/post) visits (3 mTBI)

Patient Demographics (N=37)

- Majority male
- Age 20 - 78 (Mean = 36, Median = 32)
- Gender (86% male)
- Primarily Active Duty
- 65% of total sample had a dx of TBI
 - 63% of TBI = mild TBI (n14)
- NOT mTBI subsample (n23, 10 TBI + 13 Other DX)

BFC Cognitive Retraining Exposure Rates

Total Sample w/ two ANAM assessments
(N37: n14 mTBI, n23 NOT mTBI)

Mean/Median (range, SD)

#Wks btw visits

- N37 19/15 (3-76, SD14)
- n14 23/18 (6-76, SD18)
- n23 17/14 (3-41, SD11)

Total visits

- N37 20/20 (2-62, SD14)
- n14 18/17 (3-47, SD12)
- n23 22/22 (2-62, SD15)

Sample w/ minimally accepted intensity + performance validity
(N18: n3 mTBI, n15 NOT mTBI)

Mean/Median (range, SD)

#Wks btw visits

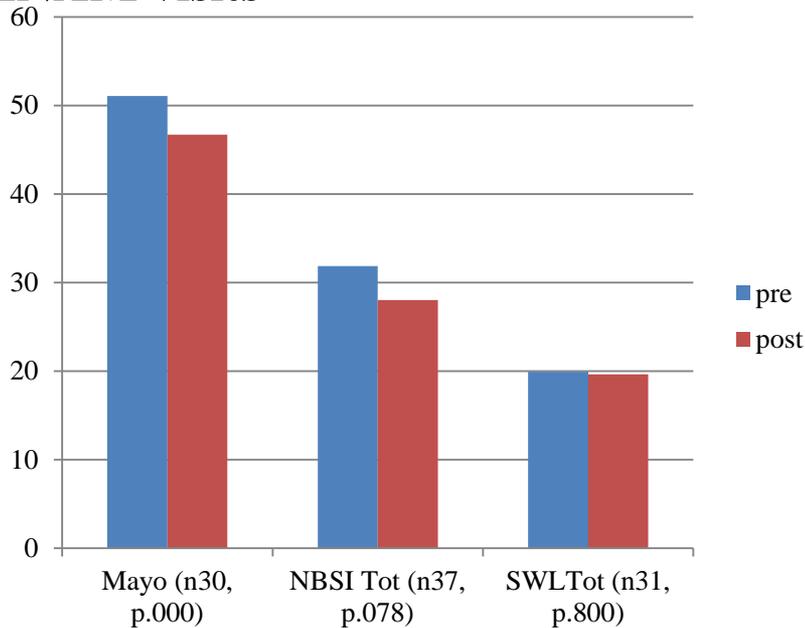
- N18 18/14 (8-41, SD10)
- n3 23/21 (13-35, SD11)
- n15 17/14 (8-41, SD11)

Total visits

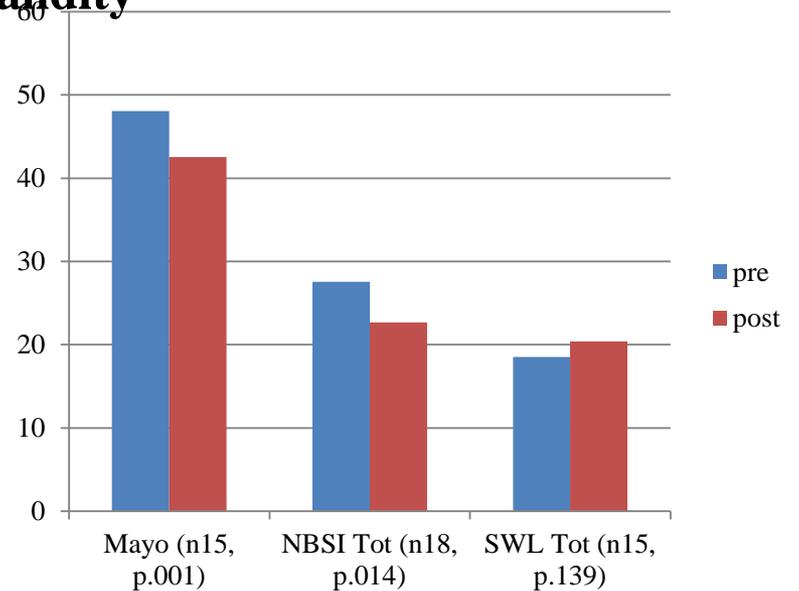
- N18 28/24 (13-62, SD15)
- n3 33/34/(17-47, SD15)
- n15 27/24 (13-62, SD13)

Symptom changes with repeat BFC visits

Total sample (n30/37) with two ANAM visits

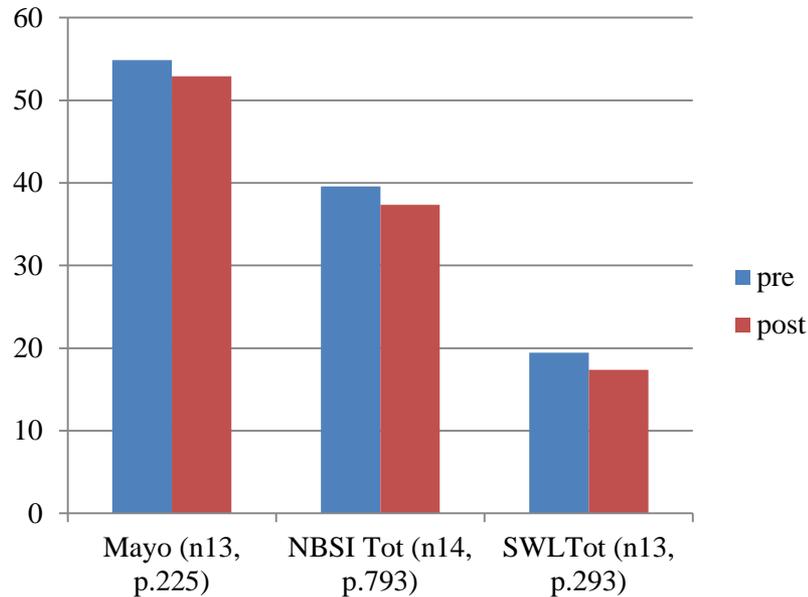


Total Sample (n15/18) w/ minimum accepted intensity + performance validity

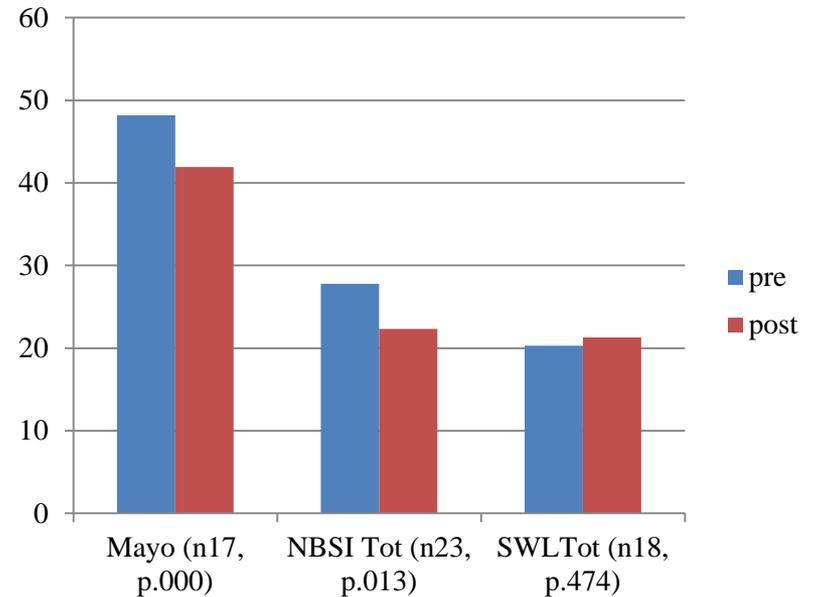


Symptom changes with repeat BFC visits

mTBI subsample (n13/14) with two ANAM visits

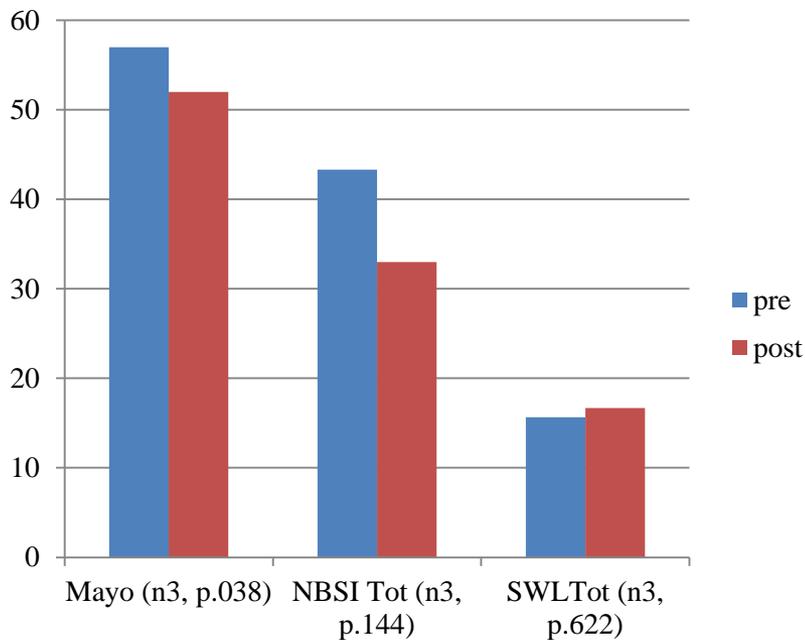


NOT mTBI subsample (n17/23) with two ANAM visits

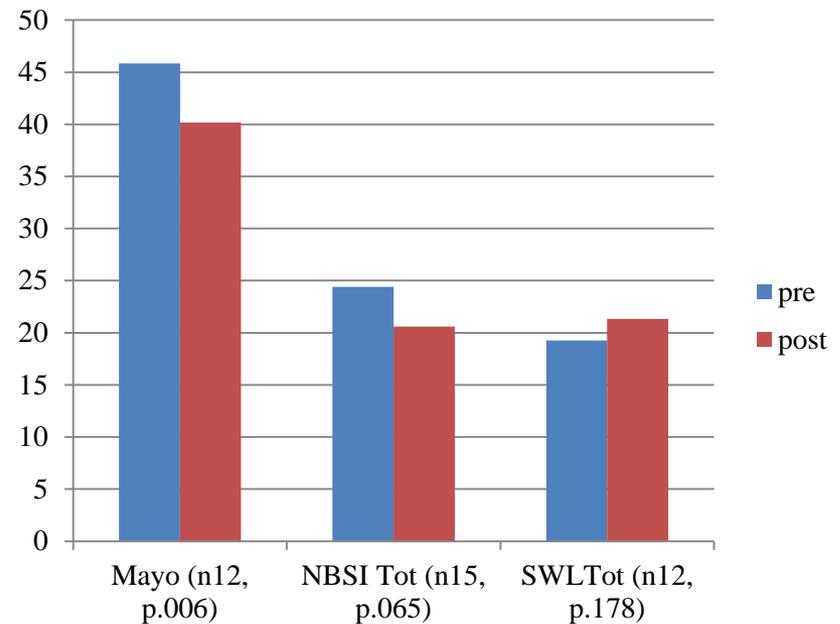


Symptom changes with repeat BFC visits

mTBI subsample (n3) w/ minimum accepted intensity + performance validity



NOT mTBI subsample (n12/15) w/ minimum accepted intensity + performance validity

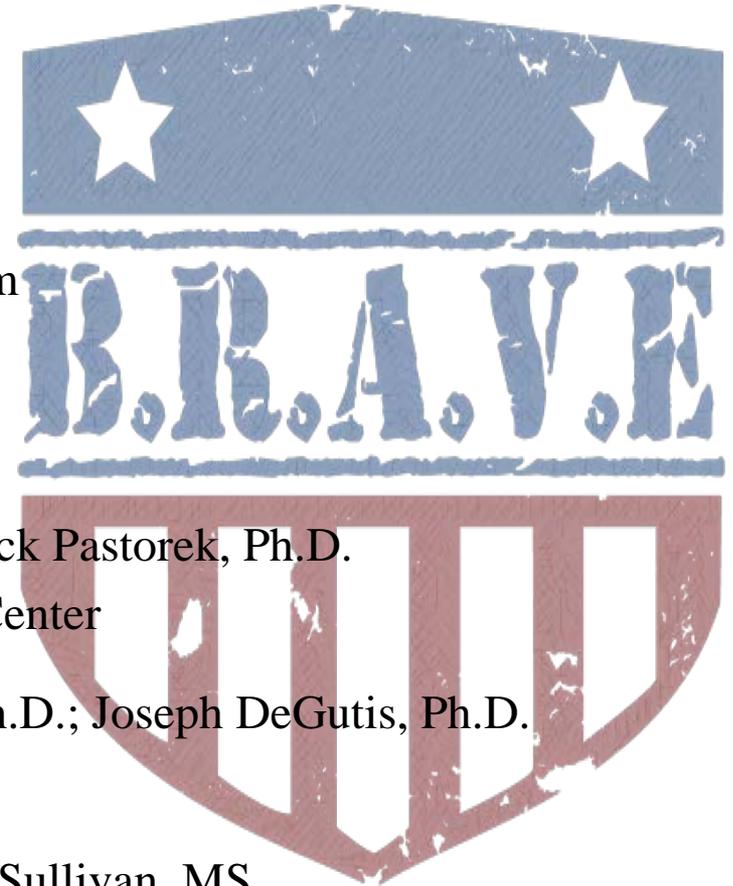


Preliminary Conclusions/Discussion

- Within a Military patient population seeking computerized cognitive retraining exercises due to subjective symptom concerns, symptom improvement is associated with intensity of participation (total visits)
- Significant improvement in subjective symptoms following participation in such exercises is moderated by performance validity on objective cognitive assessments.
- mTBI patients who endorse problematic subjective symptoms and consistently demonstrate valid performance on objective cognitive assessment may benefit from computerized cognitive retraining exercises
- Limitations
- Future directions

BRAVE Trial: Broad-spectrum Cognitive Remediation Available to Veterans: Effects of a Brain Plasticity-based Program in mTBI

- Henry W. Mahncke, Ph.D.
Brain Plasticity, Inc.
- Morris Bell, Ph.D., ABPP
Veterans Affairs Connecticut Health Care System
- Chad Grills, Ph.D.
Tripler Army Medical Center
- Harvey Levin, Ph.D.; Mary Newsome, Ph.D.; Nick Pastorek, Ph.D.
Michael E. DeBakey Veterans Affairs Medical Center
- William Milberg, Ph.D.; Regina McGlinchey, Ph.D.; Joseph DeGutis, Ph.D.
VA TBI Center of Excellence, Boston, MA
- Louis French, Psy.D.; Paul Pasquina, MD; Kate Sullivan, MS
Walter Reed National Military Medical Center



BRAVE Purpose and Objectives

- This study is a multi-site, prospective, parallel arm, double-blind, randomized, controlled clinical trial to assess the safety and efficacy of plasticity-based, adaptive, computerized cognitive remediation treatment (CRBI) versus a computer-based control.
 - Specific Aim 1: Evaluate the effect of CRBI on generalized cognitive and functional performance.
 - Specific Aim 2: Evaluate the endurance of effects following completion of CRBI use.
 - Specific Aim 3: Identify specific populations of treatment responders and non-responders



Current Pros/Cons Regarding Computer-Based Cognitive Enhancement

PROS:

- Theoretically-grounded in relation to current knowledge in neuroplasticity
- Able to reach and provide adjunctive services to patients in remote locations
- Easy for almost all patients to utilize
- Limited evidence for transfer effects beyond the training tasks (some domains better than others; e.g., attention versus language)

CONS:

- Limited empirical support (small sample sizes, lack of controls, generalizability uncertain)
- May prevent/reduce engagement in evidence-based rehabilitation services focusing on compensatory training strategies
- Professional guidance is not required
- Much of the existing research has been offered by the program developers

Poll

Which of the following are professional criticisms regarding computer (software or web-based) brain-training programs? (select all that apply)

- A. Not theoretically-grounded
- B. Inability to reach wide-ranging patient populations
- C. Too complicated for most patients
- D. Professional involvement is not necessary

Acknowledgments

Principal Investigator

- Louis M. French, PsyD

Neuropsychologist; Supervisor

- Michael Pramuka, PhD

Research Assistants

- Alanna Covington
- Laura Loyola
- Angela Perta

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Lumosity

- www.lumosity.com

Cogmed

- www.cogmed.com

Sharpbrains

- www.sharpbrains.com



Contacts and Questions

Kate Sullivan, M.S., CCC-SLP
Director, Brain Fitness Center
katherine.w.sullivan.ctr@health.mil

Wendy A. Law, Ph.D.
Clinical Neuropsychologist, WRNMMC
wendy.a.law.civ@health.mil

