

# NEUROPLASTICITY AND ADHD

Connecting with ADHD:  
3<sup>rd</sup> Annual ADHD Symposium  
Chesapeake Bay Academy  
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[www.HamptonRoadsNeuropsychology.com](http://www.HamptonRoadsNeuropsychology.com)

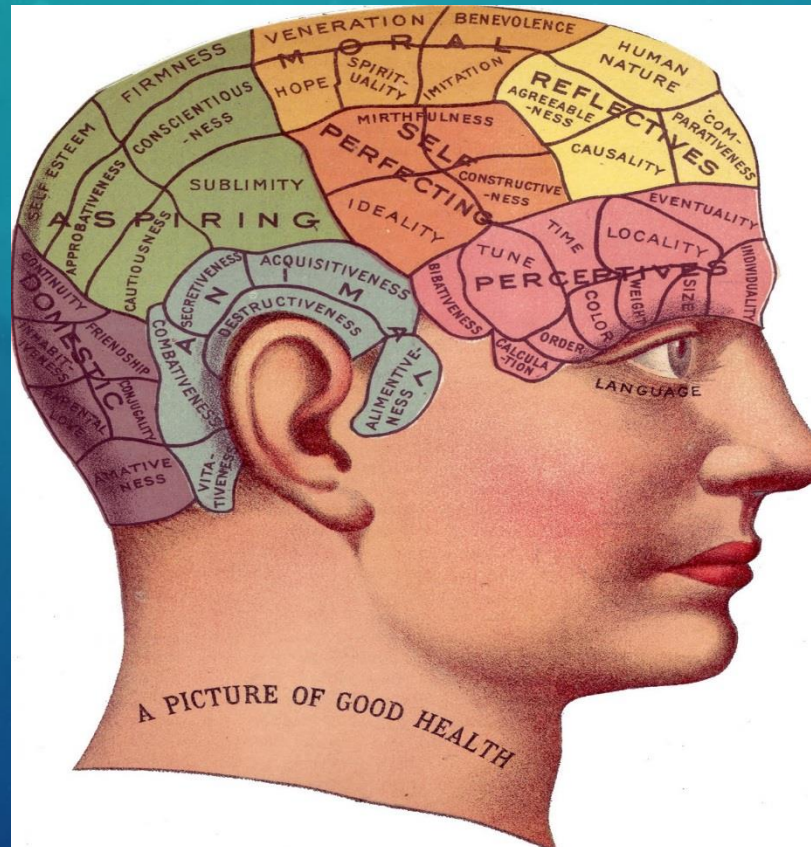
# DISCLOSURES

- 1) Independent Private Practice.
- 2) Board Certified Neuropsychologist.
- 2) Qualified Cogmed Provider.
- 3) Certified ImPACT Consultant
- 3) Chair, Table Tennis Charity Foundation.
- 4) Not an ADHD expert

# LEARNING GOALS

1. Gain an understanding of Neuropsychology.
2. Appreciate the unique contributions of Neuropsychology to Brain Fitness.
3. Describe neuroplasticity and functional neuroanatomy of ADHD.
4. Recognize evidence-based interventions promoting neuroplasticity.

# WHAT IS NEUROPSYCHOLOGY?



# DIFFERENTIAL DIAGNOSTICS AND MONITORING OUTCOME

- Normal function versus dysfunction of cognition.
- Delineate unique strengths and weaknesses within functional domains for treatment planning. Monitor changes across time.
- Assess functional outcome of treatments.

# HOW IS NEUROPSYCHOLOGY RELATED TO BRAIN FITNESS?



# BRAIN FITNESS AND NEUROPLASTICITY

- Diet, exercise, stress, sleep, mentally challenging activities and social engagement.
- Resulting brain dynamics vary across individuals and are modified by genetic predisposition, environmental influences, life experiences and age.

# ADHD STATISTICS AND BEHAVIOR

- Preschool onset
- 3-9% incidence, with 3x more males
- 3 Types ADD, ADHD & Combined
- Co-morbidity: lower achievement, LD, subtle cognitive deficits, conduct disorder, poor social relations, increased anxiety and depression
- Behavioral disinhibition
- Executive dysfunction (affectively and cognitively)
  - Behavioral inhibition and attention
  - Self-regulation, working memory, planning, cognitive flexibility



# NEUROANATOMY OF ADHD

- Frontostriatal Network contributing to the pathophysiology of ADHD
- Network involves dopaminergic pathways
  - Lateral pre-frontal cortex
  - Dorsolateral anterior cingulate gyrus
  - Caudate and putamen
  - Other cortical regions and cerebellum

# NEUROSCIENCE MODEL OF ADHD

- Widespread volume reduction throughout cerebrum and cerebellum.
- Functional imagery showed more diffuse activation compared to controls during cognitive tasks.
- Reduction in volume
  - Total cerebrum volume
  - Pre-frontal cortex
  - Basal ganglia and striatum
  - Dorsal anterior cingulate cortex
  - Corpus callosum
  - Cerebellum

# NEUROSCIENCE MODEL OF ADHD

- Hypoactivation
  - Dorsal anterior cingulate cortex
  - Frontal cortex
  - Basal ganglia and striatum
- Paradigms used in the fMRI imaging tasks
  - Motor inhibition (similar to the Gordon Diagnostic System)
  - Interference and attention
    - Luria Go No-Go
    - Stop-Signal
    - Stroop Effect

# Brain Fitness Myth Busters

The background is a gradient of teal and blue, featuring several faint, circular patterns and numbers. In the top right, there is a large circular scale with numbers ranging from 0 to 220. In the bottom right, there is a smaller circular scale with numbers ranging from 0 to 120. In the bottom left, there is a partial circular scale with numbers ranging from 0 to 100. The overall aesthetic is clean and modern, with a focus on data and technology.

# MYTH BUSTER #1

- Genes determine the fate of our brains.
- Fact: Lifelong brain plasticity means that our lifestyles and behaviors play a role in our brain and therefore our minds physically evolve.

## MYTH BUSTER #2

- Medication is the main hope for cognitive health and enhancement.
- Fact: Non-invasive interventions can have comparable and more durable benefits, and are also free of side effects.

# MYTH BUSTER #3

- Brain training does not work.
- Fact: Brain training, when it meets certain conditions, has been shown to improve brain functions in ways that enhance real-world outcomes.

# CONTRIBUTIONS TO THE FRAMEWORK OF NEUROPLASTICITY

- Dr. Lambert's *Clinical Neuroscience* and neurobiological homeostasis
- Dr. Antonovski's Theory of Salutogenesis
- Sir William Osler's quote on illness
- Sharp Brain's guide to brain fitness



# NEUROBIOLOGICAL HOMEOSTASIS

- Brain-Body Balance (toward healthy brain fitness)
  - Establishing neurobiological homeostasis
  - Balance of these systems involves how the body and brain respond to stress
  - Disruption of these internal systems by stress or illness
  - Maintaining homeostasis in light of these events requires adaptation

# BRAIN FITNESS AND NEUROPLASTICITY

- Innovative experimental paradigms can access cortical plasticity across the lifespan.
- Changes in brain plasticity may prove maladaptive
- Aberrant plasticity may represent an approximate cause of neurodevelopmental disorders such as ADHD
- However, optimizing activity within and across brain structures promoting brain health would sustain cognitive function and well-being.

# BRAIN HEALTH MATTERS

- Disability after a brain insult is the consequence of neuroplasticity.
- Neurostimulation, including non-invasive brain stimulation techniques provide an opportunity to capitalize on modulating plastic brain networks in controlled and specific manners.
- There is a growing body of evidence supporting this, and one leader in the field is [www.SharpBrains.com](http://www.SharpBrains.com).

# BIOPSYCHOSOCIAL MODEL

- Recognition that many health problems have not only a biological component, but psychological and social ones as well.
- Prescient 18<sup>th</sup> Century Physician, Sir William Osler said it was as important to know the man who has an illness, as to know the illness that a man has.

# ILLNESS AND HEALTH

- Pathogenesis
  - Disease processes
  - Refers to negative health
- Salutogenesis
  - Latin for health or well-being
  - Refers to the processes of positive health

# RELATED TERMS OF SALUTOGENESIS

- Sense of coherence
- Hardiness
- Coping
- Optimism
- Gratitude
- Social support
- Religion and Faith
- Happiness
- Humor
- Love

# NEUROSCIENCE OF BRAIN FITNESS

- Neuroplasticity
- Enriched and Stimulating Environments
- Challenging Activities

# COMPLIMENTARY FACTORS AFFECTING NEUROPLASTICITY

- Heart Health Diet
- Quality Sleep Hygiene
- Stress Reduction
- Avoiding toxic substances
- Socialization
- Education





Source: The SharpBrains Guide to Brain Fitness (second edition)

# NEW AND PROMISING TECHNOLOGIES

- Task specific neurofeedback
- Better meditation and mindfulness practice
- Non-invasive cognitive enhancement through targeted exercises
- Sensorimotor and physiological improvements via virtual reality

# NEUROSTIMULATION

- Lumosity (cognitive training)
- Headspace (mindfulness)
- BrainHQ (Double Decision, speed of information processing)
- Cognifit (cognitive training)
- Emotiv (EEG)
- Cogmed (working memory training)

# THE KEY TO BRAIN TRAINING

Cognitive Skill  
of Working  
Memory



# Neuroplasticity makes Working Memory training possible

The brain can physically  
change in response to  
**focused repeated  
intensive activity -  
training**

Improved working memory  
**generalizes** to other  
cognitive abilities and  
behavior



# Five conditions to maximize transfer

To maximize real-world value of training...

1. Target neural processes that support real-world activities
2. Minimum “dose” of ~15 hours of training per targeted improvement
3. Address an individual’s bottleneck/ deficit
4. Adaptive challenge
5. Continued practice

Source: The SharpBrains Guide to Brain Fitness

**What does the “BBC brain training study” (2010, 2015) prove?**

# COGMED RESEARCH FINDINGS

- 60+ published articles in peer reviewed journals
- 70+ research studies currently underway
  - Improved neuropsychological test performance
- Increased frontal lobe activity in the brain
- Improved concentration and math skills
- Improved reading comprehension
- More info and free trial: [www.MyCogmed.com](http://www.MyCogmed.com)

# WHY IS CROSS TRAINING YOUR BRAIN IMPORTANT?

- Aerobic exercise
- Solving challenging mental problems
- Stress management
- Quality sleep hygiene
- Nutritional diet
- Social connections and relationships



# AEROBIC EXERCISE EFFECT ON THE BRAIN

- Colcombe, S.J. et al. (2006) Aerobic exercise training increases brain volume in aging adults. *Journal of Gerontology*, Vol 61A (11), 1166-1170.

BREDESEN (2014) REVERSAL OF COGNITIVE  
DECLINE: A NOVEL THERAPEUTIC PROGRAM.  
*AGING*, VOL. 6, NO. 9, 707-717

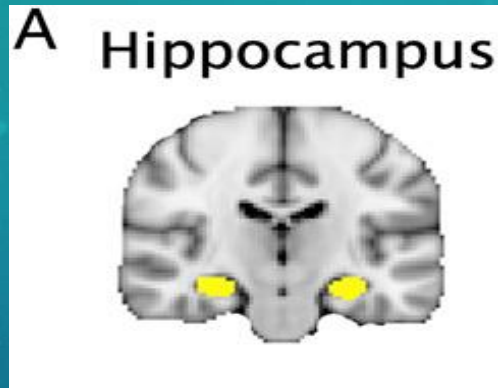
- Diet, reduce stress, optimize sleep, exercise, brain stimulation, hormone balance, blood labs, vitamins, anti-oxidants

# PHYSICAL ACTIVITY AND BRAIN PLASTICITY

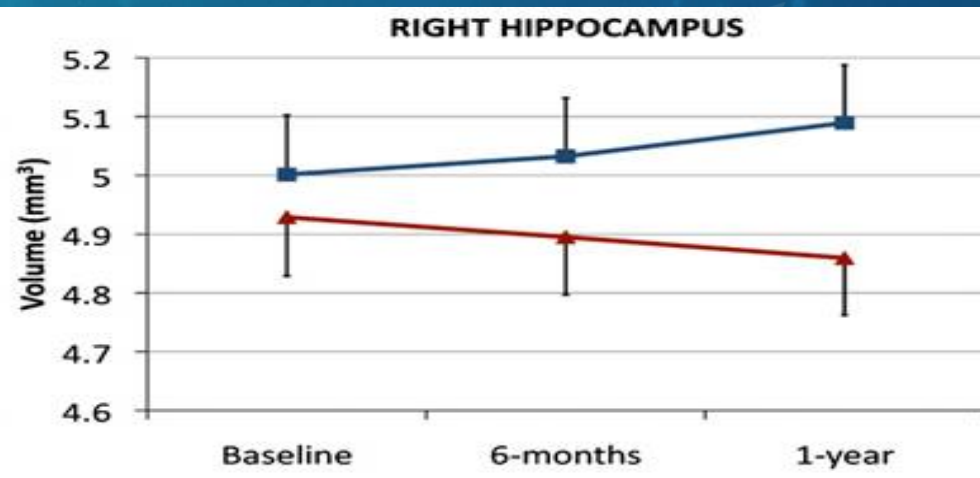
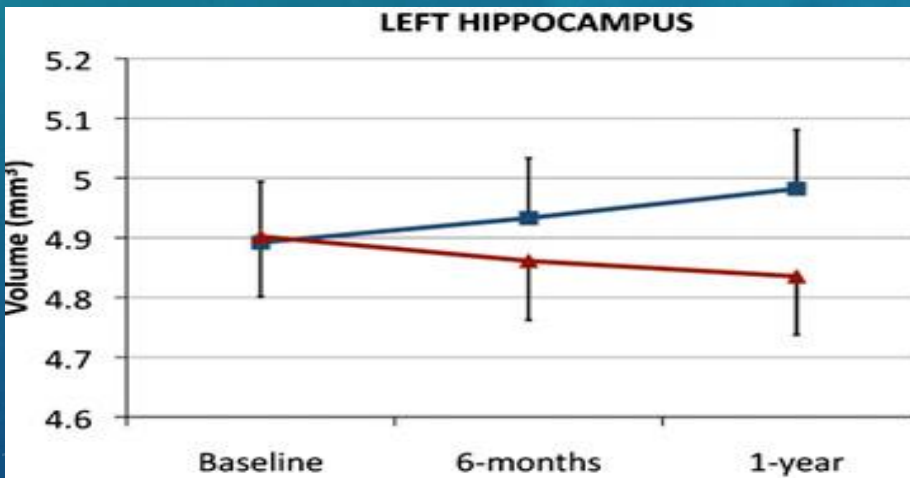
## *JINS* 2015 SPECIAL ISSUE

- Basso, J.C. et al. Acute exercise improves prefrontal cortex.
- Reiter, K. et al. Improved cardiorespiratory fitness is associated with increased cortical thickness in mild cognitive impairment.
- Alosco, M.L. et al. Daily physical activity is associated with subcortical brain volume and cognition in heart failure.
- Barcelos, N. et al. Executive function improves with cognitive challenge while exergaming
- Llamas-Velasco, S. et al. Physical activity as protective factor against dementia

# EXERCISE INCREASES SIZE OF HIPPOCAMPUS AND IMPROVES MEMORY (ERICSON, 2010)



■ Exercise  
▲ Stretching



# COGNITIVE TRAINING MAY PROTECT AGAINST ONSET OF DEMENTIA (NIH, 2016)

- 1. Speed-of-processing training reduced risk in developing cognitive decline.
- 2. Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) nearly 3K participants randomized in 4 groups 1) memory training, 2) reasoning training, 3) computerized speed-of-processing training, and 4) a control group.
- 3) Speed-of-processing training was the only one to show a statistically significant impact on cognitive decline at 10 years with a 33 percent reduction in risk in developing dementia during the time of the study.
- 4) First time cognitive training intervention has been shown to protect against dementia in a large, randomized and controlled design.

# EXERCISE, STRATEGIZE & SOCIALIZE

- What if you could combine known factors in promoting neuroplasticity into one activity?
  - Challenging speed of processing information.
  - Mentally challenging task of strategizing and planning.
  - Aerobic exercise improving cardiovascular efficiency.
  - Balance and eye-hand coordination.
  - Socialization and developing relationships.

# WHAT ABOUT PING PONG?

- Kwano, Mimura & Kneko (1992) The effect of table tennis practice on mental ability.
- Mori & Sato (1997) The effectiveness of exercise intervention on brain disease patients: Utilizing table tennis as a rehabilitation program.
- Sautter, et al. (2015). Ping Pong and Well-Being.
- Campbell & Sautter (2015). Ping Pong and Math.

# Table Tennis Charity Foundation Sports and Education Program

- Increases concentration and alertness
- Stimulates brain function
- Develops tactical thinking skills
- Develops eye-hand coordination
- Provides aerobic exercise
- Provides social and recreational interaction





# DR. AMEN'S PRESCRIPTION FOR BRAIN FITNESS AND OPTIMIZING NEUROPLASTICITY

- Reduce stress
- Get plenty of sleep
- Avoid substances that stress the brain
- Take multivitamins
- Counteract “internal ANT-eaters”
- Regular exercise such as playing Ping Pong
  - “The Greatest Brain Sport”

# QUESTIONS TO CONSIDER ABOUT BRAIN TRAINING

- Based on scientific research?
- Measurable claims and benefits?
- Ensures cross-training?
- Is it exercise or entertainment?
- Good fit for me?

# 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?

# 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?

# ENSURES CROSS-TRAINING?

6. Do the exercises vary and teach me something new?

# IS IT EXERCISE OR ENTERTAINMENT?

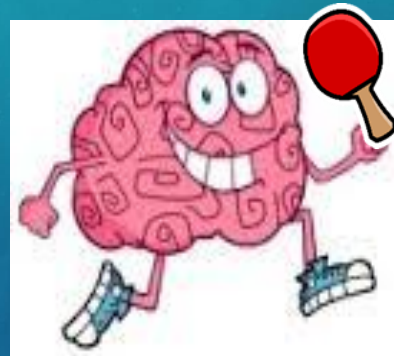
7. Does the program challenge and motivate me, or does it feel like it would become easy once I learned it?

# 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?



# Promote Neuroplasticity by Cross Training Your Brain: Play Ping Pong!



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