Neuroplasticity, Brain Reserve, and Aging:

How to Improve Your Brain Performance

by Growing the Size of Your Hippocampus,

At Any Age

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NeuroGrow
BRAIN FITNESS CENTER

Neuroplasticity in the Human Brain: Translational Research

Modifiable factors that alter the size of the hippocampus with ageing

Majid Fotuhi, David Do and Clifford Jack

Abstract | The hippocampus is particularly vulnerable to the neurotoxic effects of obesity, diabetes mellitus, hypertension, hypoxic brain injury, obstructive sleep apnoea, bipolar disorder, clinical depression and head trauma. Patients with these conditions often have smaller hippocampi and experience a greater degree of cognitive decline than individuals without these comorbidities. Moreover, hippocampal atrophy is an established indicator for conversion from the normal ageing process to developing mild cognitive impairment and dementia. As such, an important aim is to ascertain which modifiable factors can have a positive effect on the size of the hippocampus throughout life. Observational studies and preliminary clinical trials have raised the possibility that physical exercise, cognitive stimulation and treatment of general medical conditions can reverse age-related atrophy in the hippocampus, or even expand its size. An emerging concept—the dynamic polygon hypothesis—suggests that treatment of modifiable risk factors can increase the volume or prevent atrophy of the hippocampus. According to this hypothesis, a multidisciplinary approach, which involves strategies to both reduce neurotoxicity and increase neurogenesis, is likely to be successful in delaying the onset of cognitive impairment with ageing. Further research on the constellation of interventions that could be most effective is needed before recommendations can be made for implementing preventive and therapeutic strategies.

Fotuhi, M. *et al. Nat. Rev. Neurol.* **8**, 189–202 (2012); published online 13 March 2012; doi:10.1038/nrneurol.2012.27

Changing perspectives regarding late-life dementia

Majid Fotuhi, Vladimir Hachinski and Peter J. Whitehouse

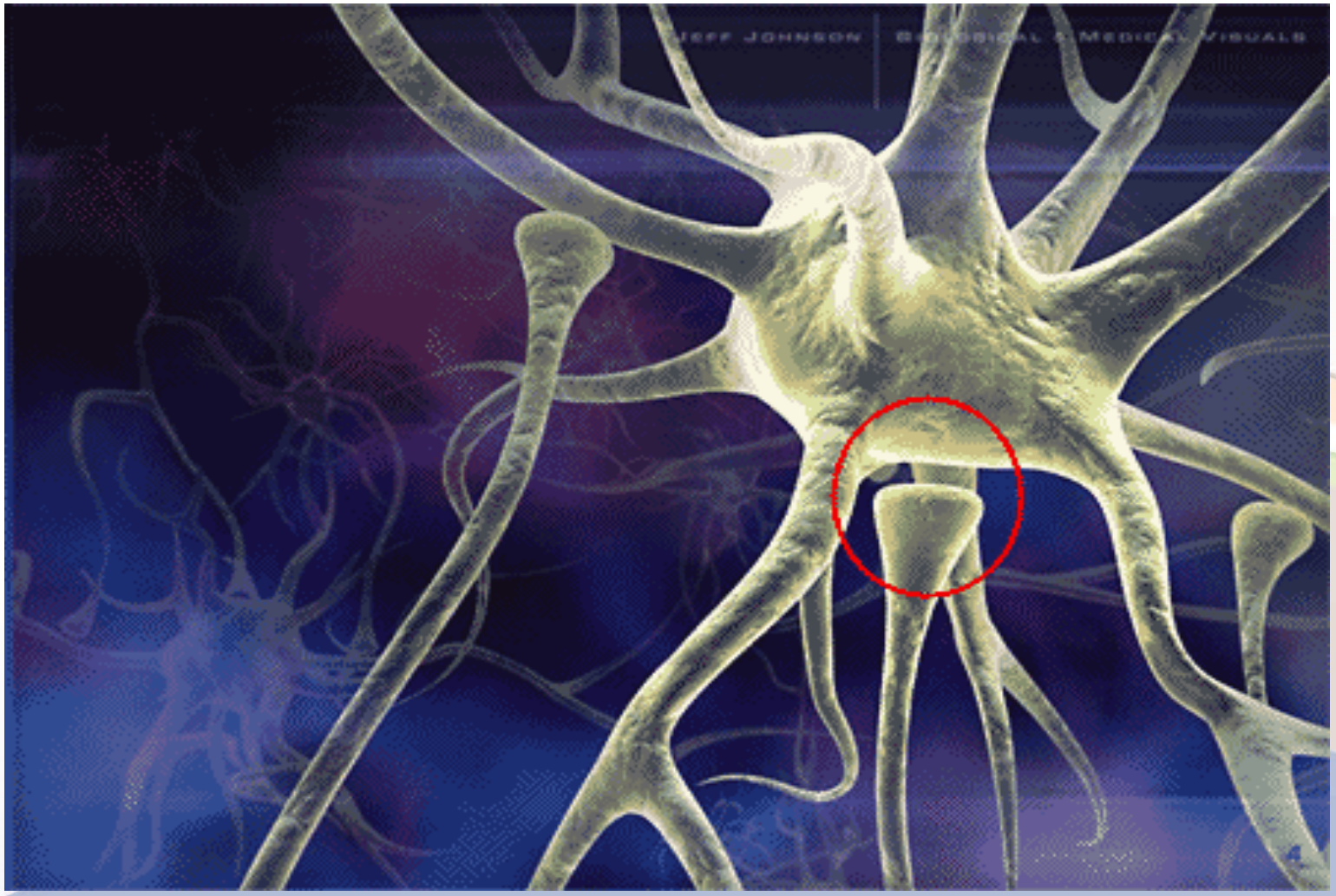
Abstract | Individuals over 80 years of age represent the most rapidly growing segment of the population, and late-life dementia has become a major public health concern worldwide. Development of effective preventive and treatment strategies for late-life dementia relies on a deep understanding of all the processes involved. In the centuries since the Greek philosopher Pythagoras described the inevitable loss of higher cognitive functions with advanced age, various theories regarding the potential culprits have dominated the field, ranging from demonic possession, through 'hardening of blood vessels', to Alzheimer disease (AD). Recent studies suggest that atrophy in the cortex and hippocampus—now considered to be the best determinant of cognitive decline with aging—results from a combination of AD pathology, inflammation, Lewy bodies, and vascular lesions. A specific constellation of genetic and environmental factors (including apolipoprotein E genotype, obesity, diabetes, hypertension, head trauma, systemic illnesses, and obstructive sleep apnea) contributes to late-life brain atrophy and dementia in each individual. Only a small percentage of people beyond the age of 80 years have 'pure AD' or 'pure vascular dementia'. These concepts, formulated as the dynamic polygon hypothesis, have major implications for clinical trials, as any given drug might not be ideal for all elderly people with dementia.

Fotuhi, M. *et al. Nat. Rev. Neurol.* **5**, 649–658 (2009); published online 17 November 2009; doi:10.1038/nrneurol.2009.175

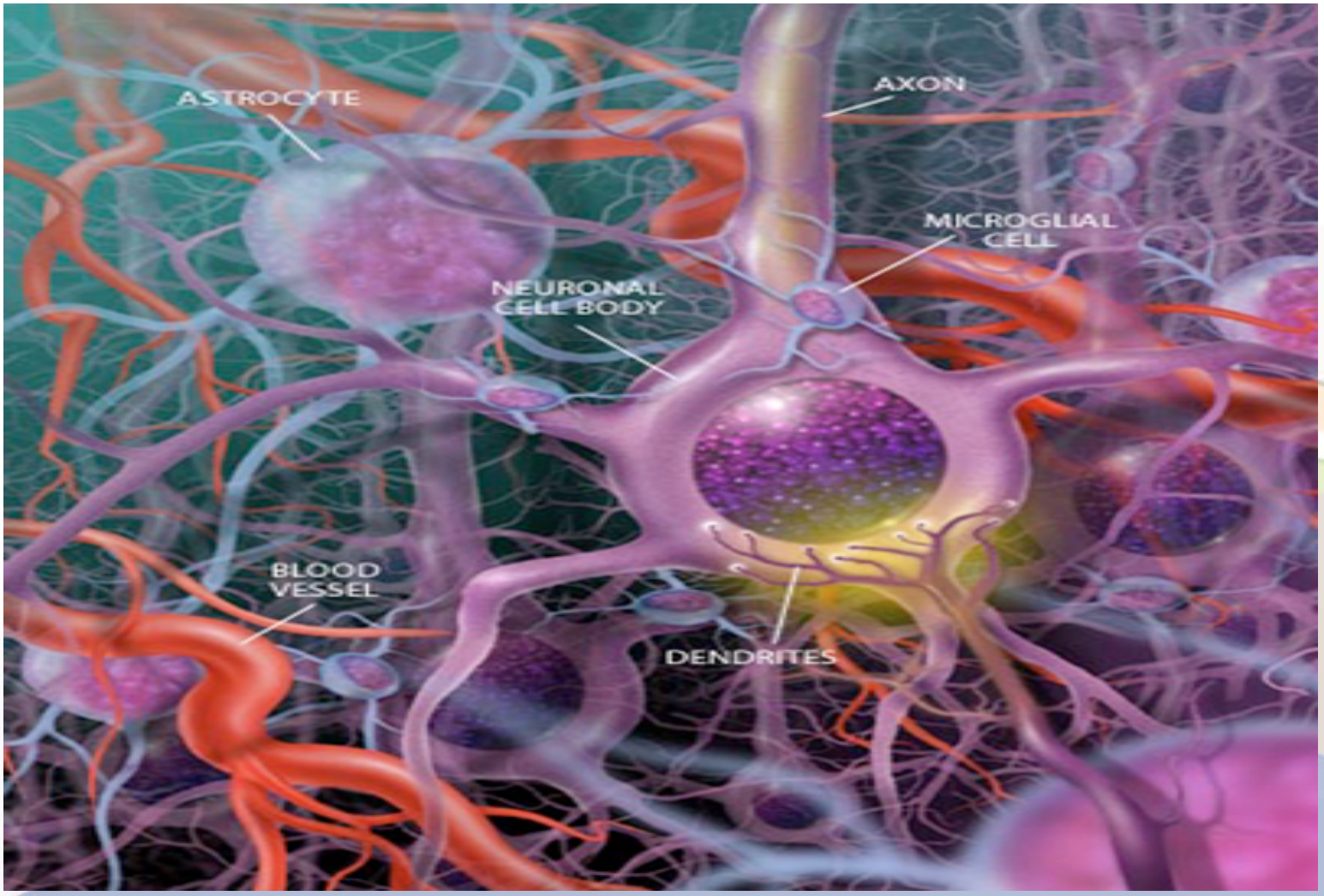
Objectives

1. Basic Anatomy of Cognition
2. Memory Loss and Brain Atrophy with Aging
3. Brain Reserve & Neurogenesis
4. Six Ways to Grow Your Brain
5. Reversing Brain Atrophy in Elderly, in 3 Months

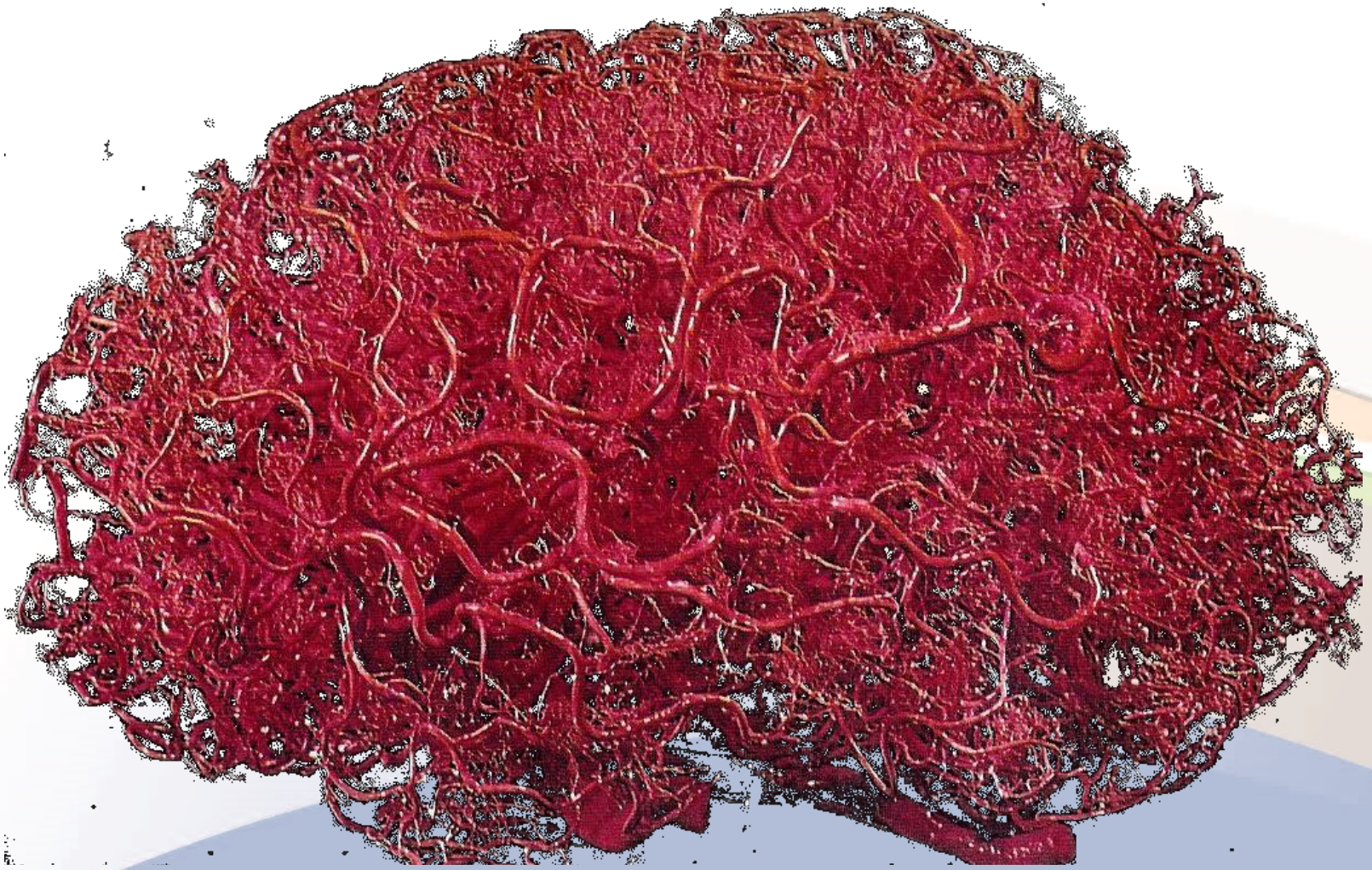
Synapses



Blood Vessels



Brain is a Highly Vascular Organ



Zlokovic et al. Neurosurgery 43(4), 877–78, 1998

Anatomy of Cognition: Cortex

Executive function

Language

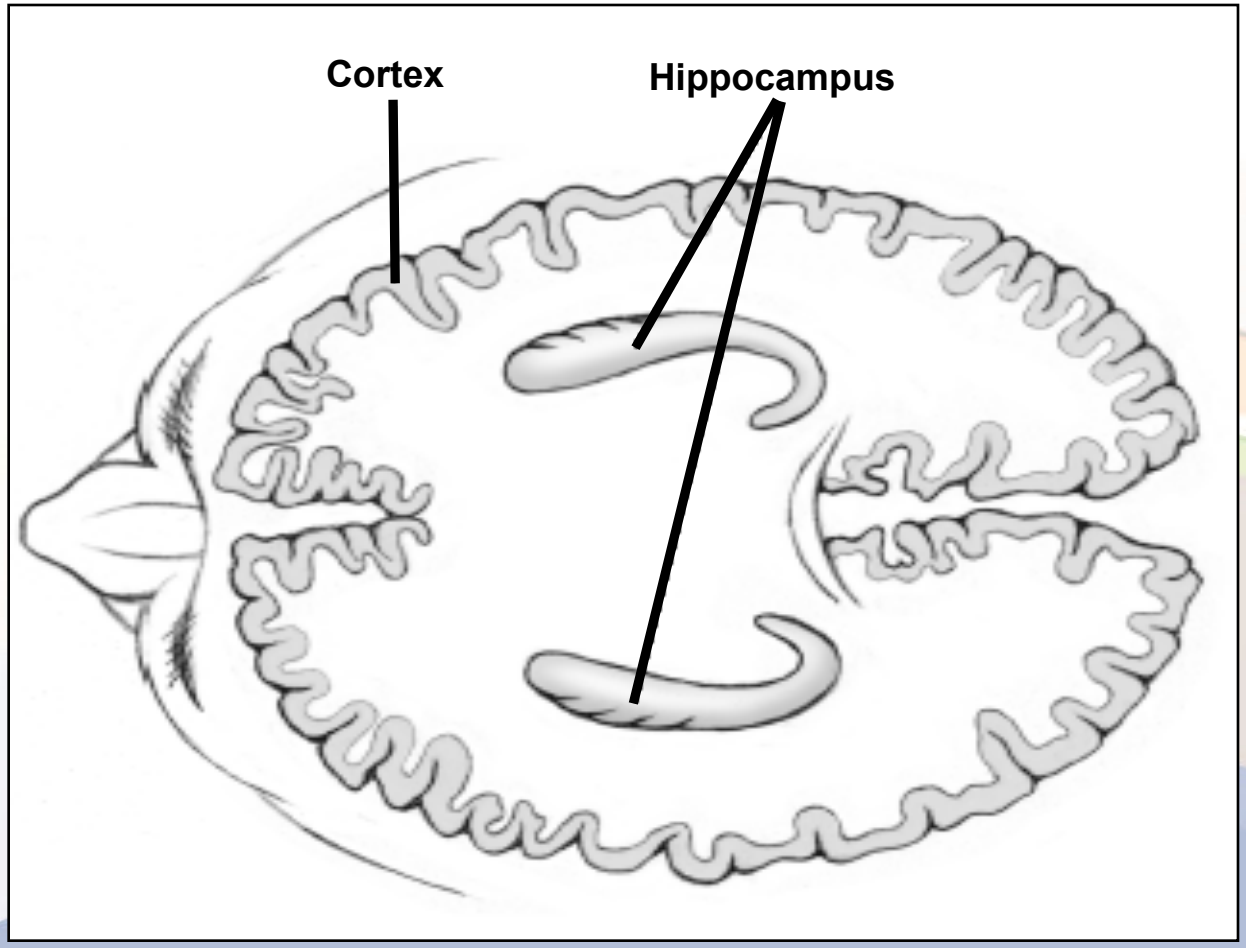
Navigation

Calculation

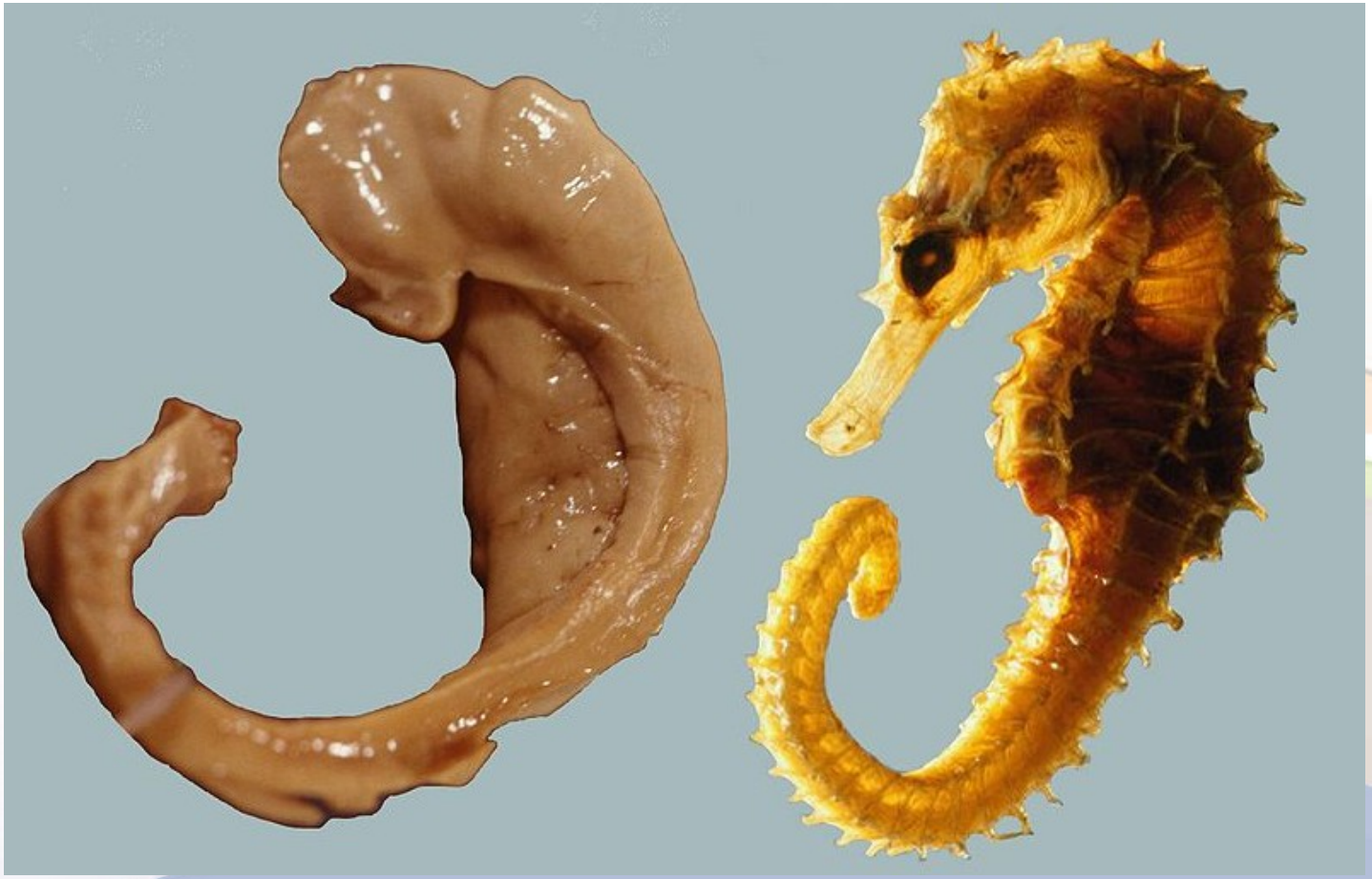
Abstract thinking

Long term memory

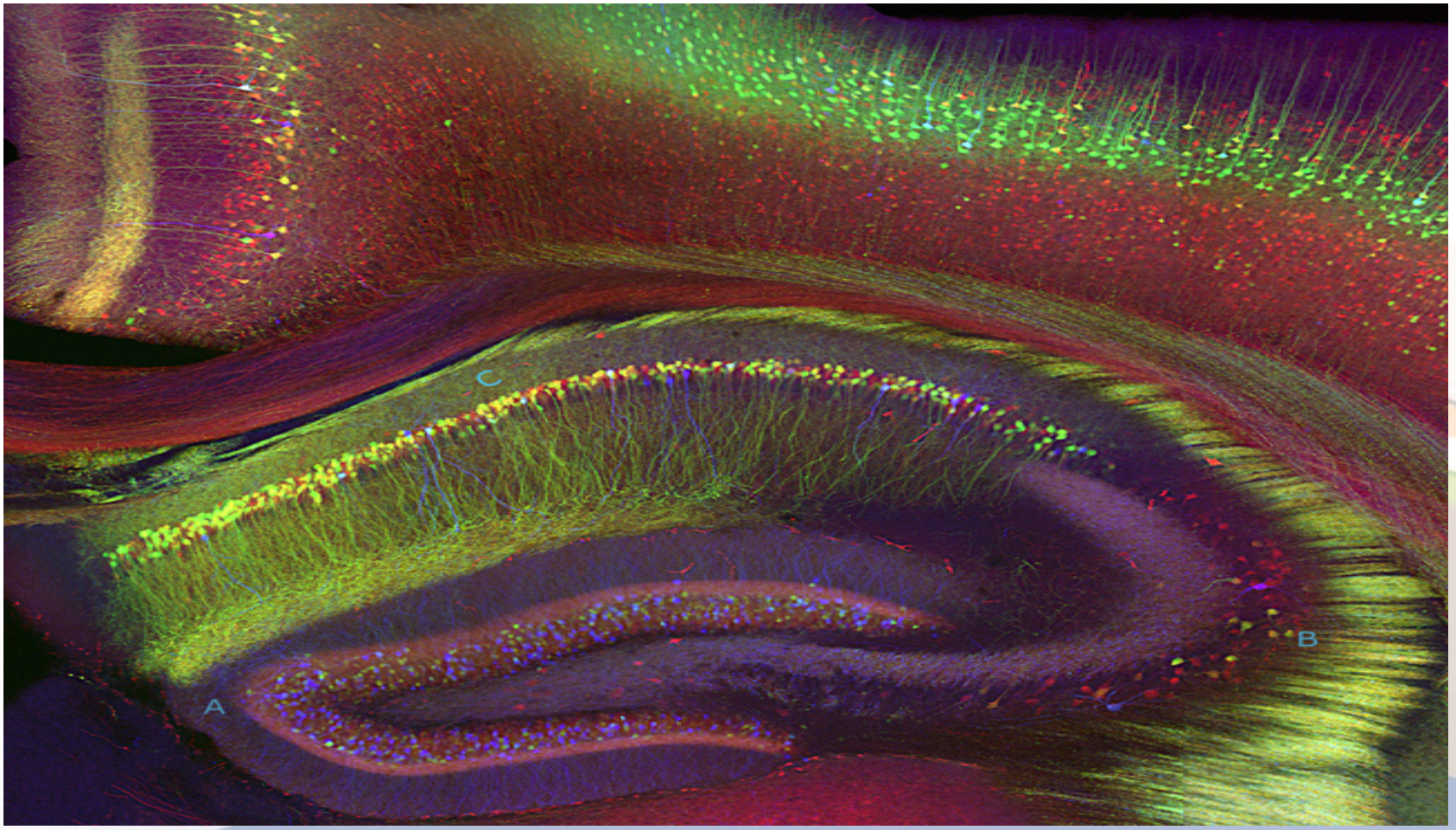
Short-term Memory & Consolidation: Hippocampus



Hippocampus



Neurons in Hippocampus



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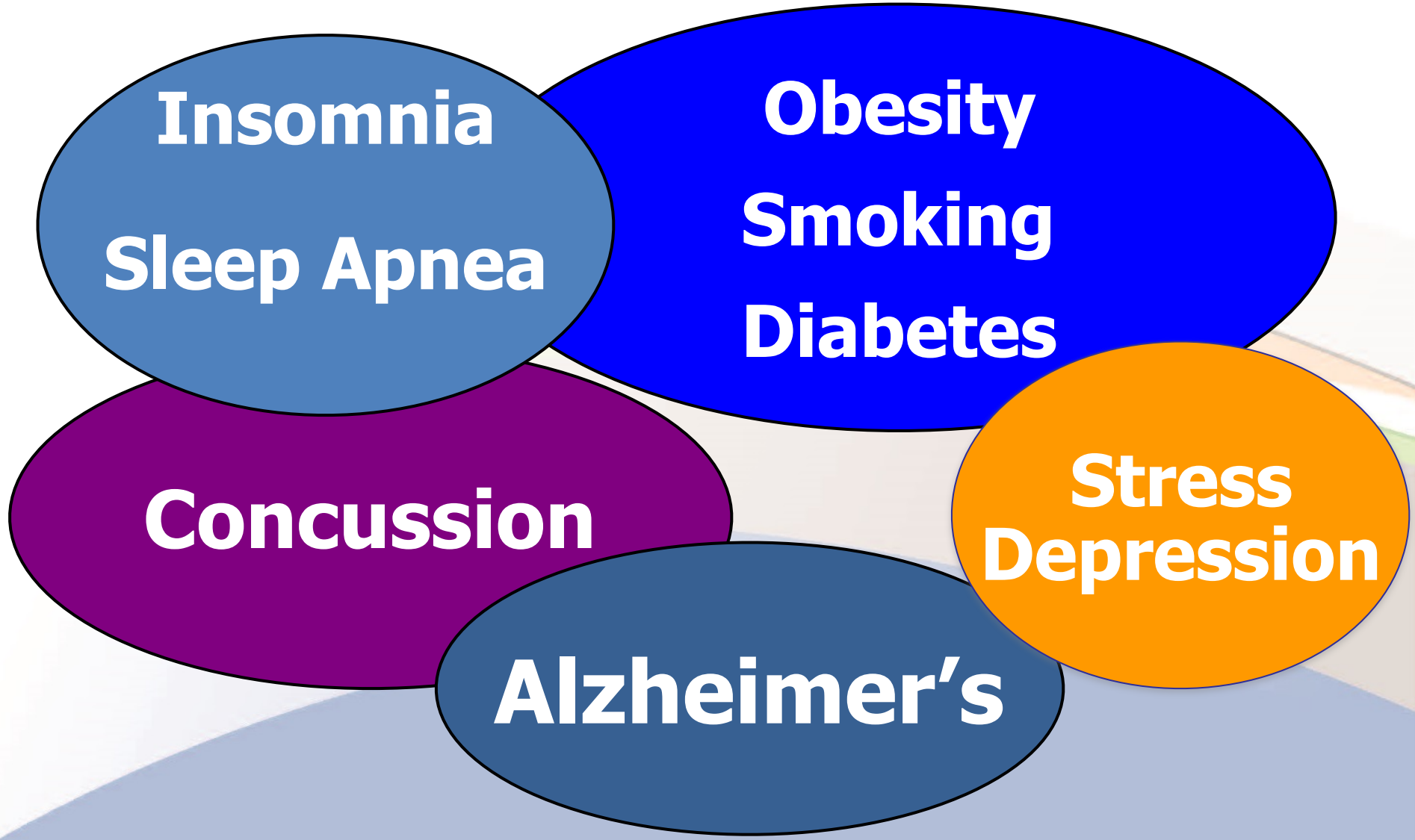
With Aging, Hippocampus Atrophies Faster than the Rest of the Brain

- **Hippocampus shrinks by about 0.5% per year after age 40.**

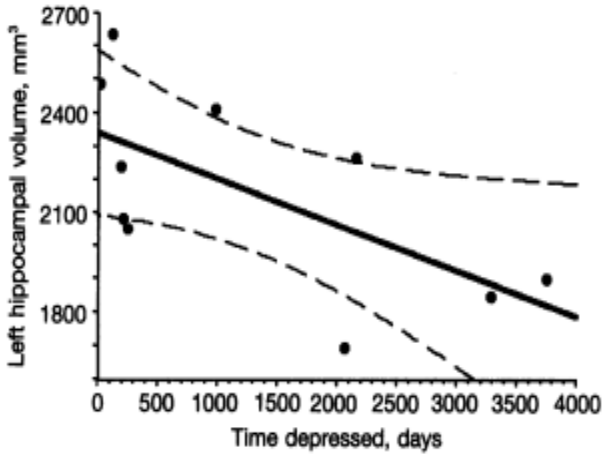
- **That is the main reason memory lapses become more frequent after age 40.**

What Causes Atrophy in Hippocampus?

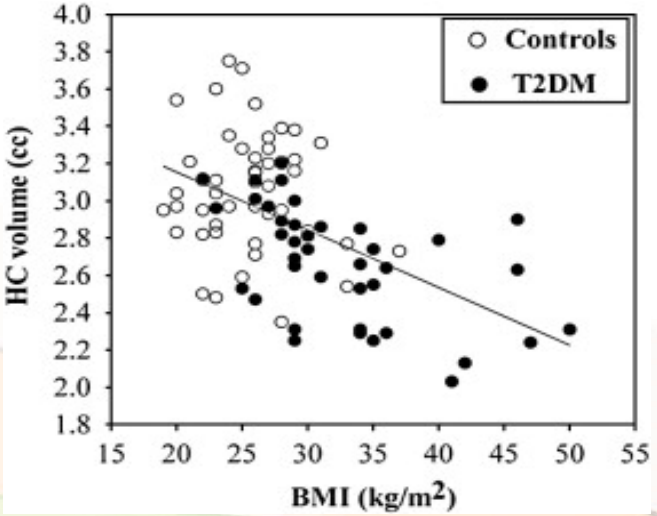


More Depression, Obesity, Stress, and Insomnia, Smaller Hippocampus

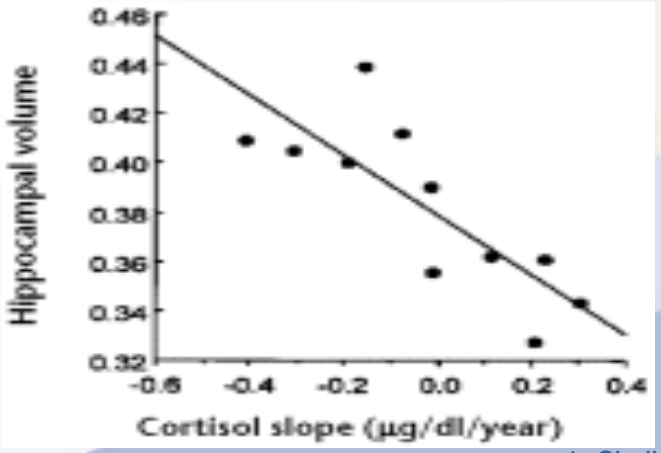
Depression[1]



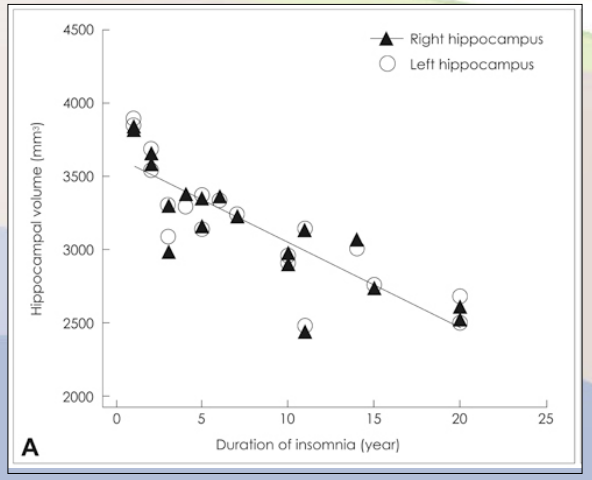
Obesity[2]



Cortisol / Stress[3]



Insomnia[4]



1- Sheline, (1996). *PNAS*, 93(9);3908-13.

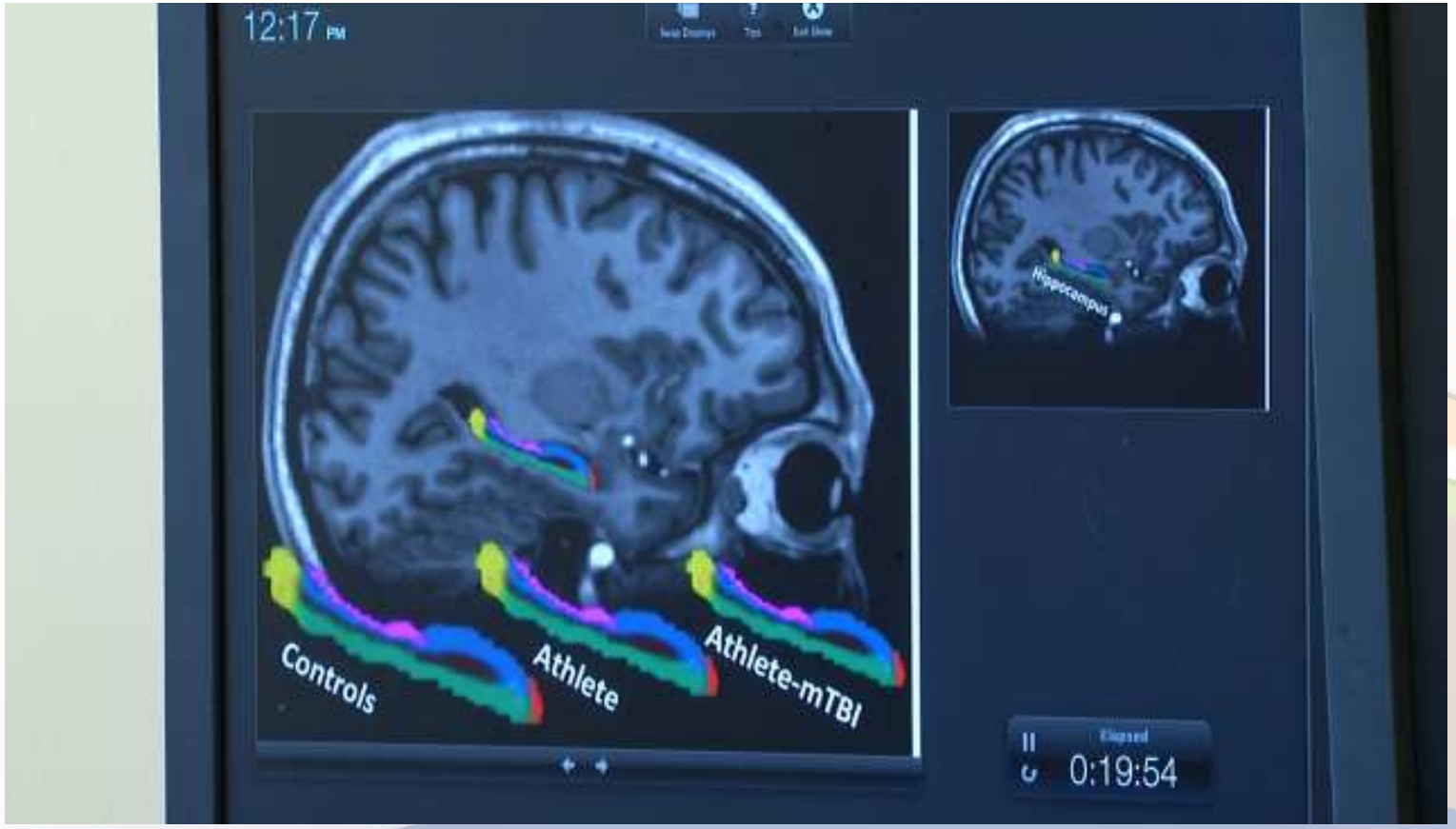
2- Brain Research, 2009, Pages 186–194

3- Lupien et al (1998), Nature NeuroSci 1 (1), 69-73

4- Ho et al; J Clin Neurol. 2012 Jun;8(2):130-8

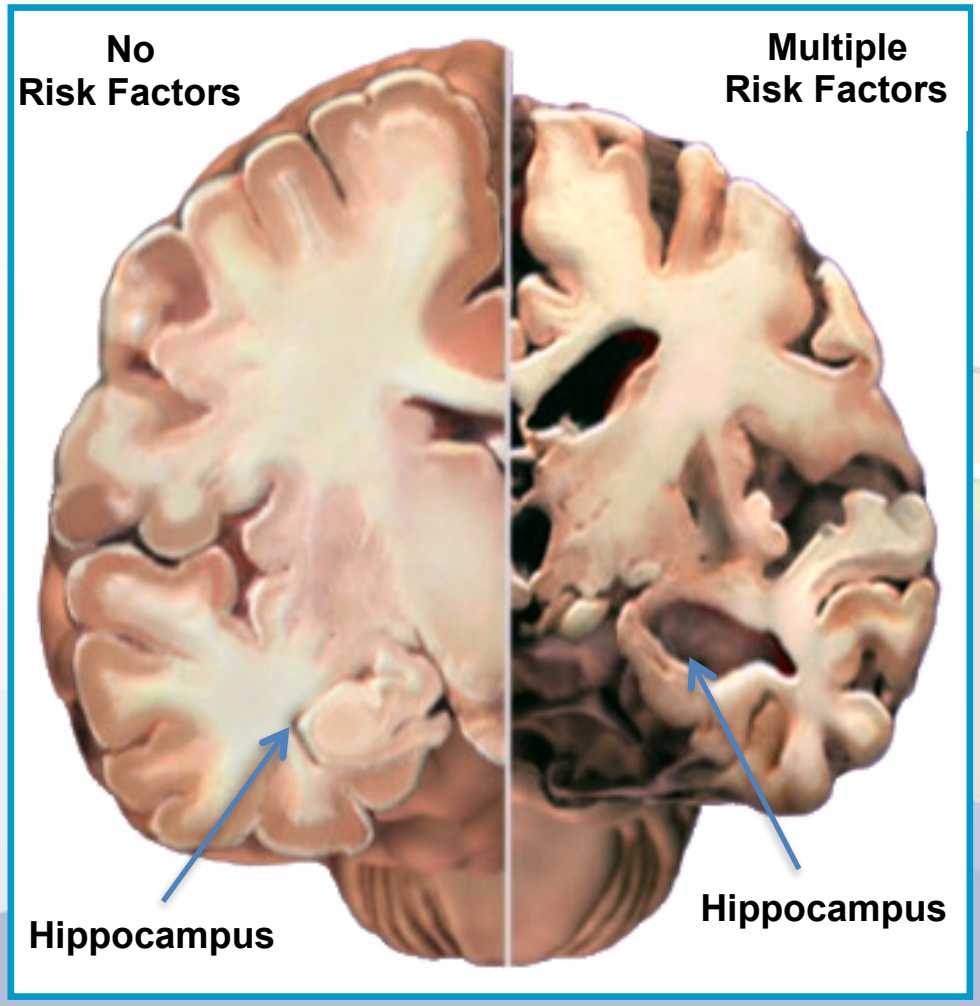
More Traumatic Brain Injury (TBI), Smaller Hippocampus

More Football, Smaller Hippocampus



Singh, JAMA neurology, 2014

Multiple Risk Factors, Much Smaller Hippocampus



Brain-healthy Diet
Physical Fitness
Cognitive Stimulation
Quality sleep
Peace of Mind

Diabetes
Hypertension
Obesity
Sleep Apnea
Insomnia
Head Trauma
Genes
Stress

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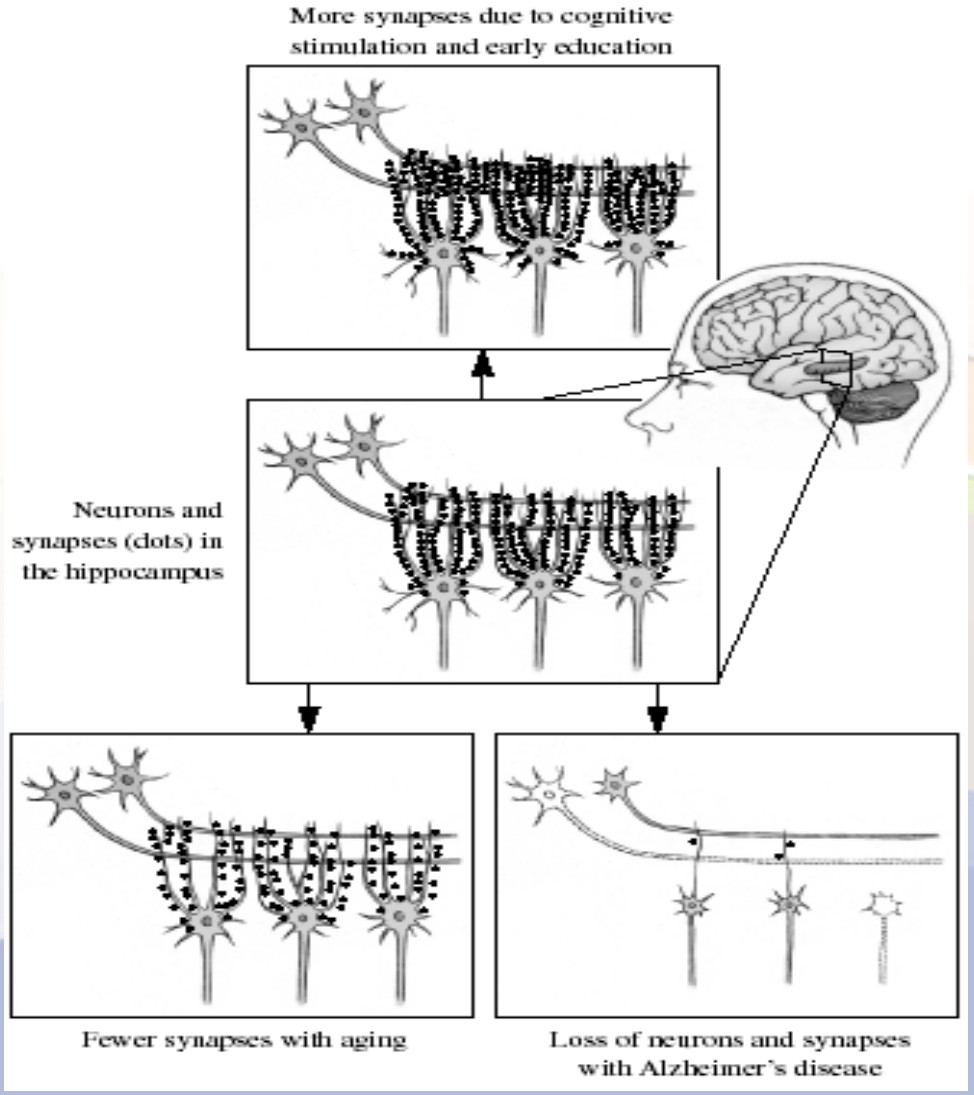
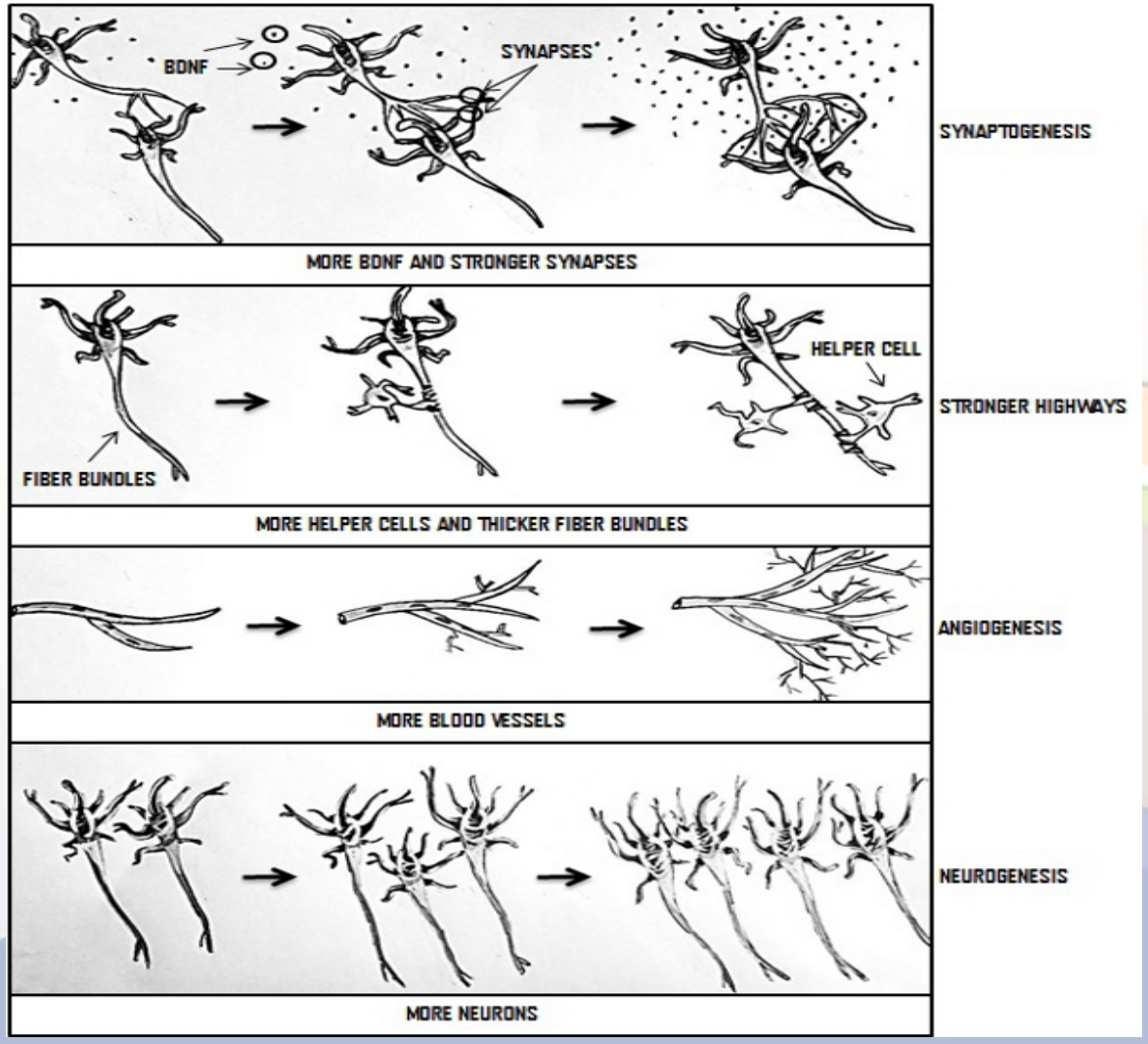
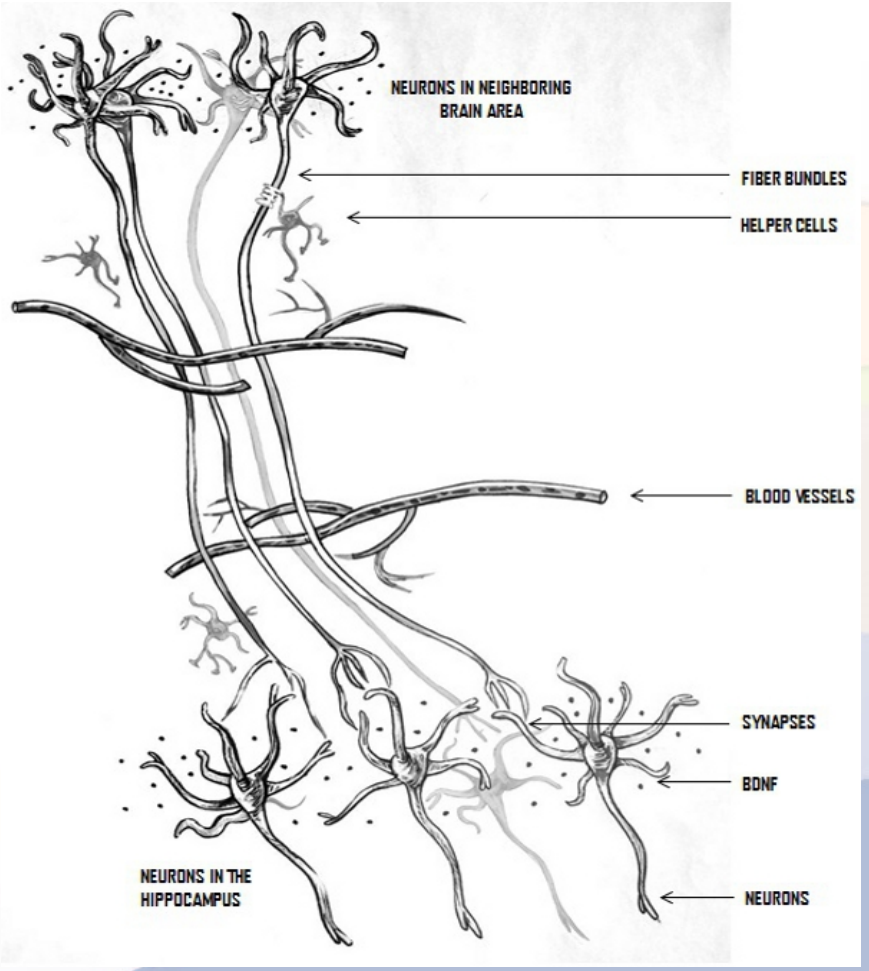
“Brain Reserve”

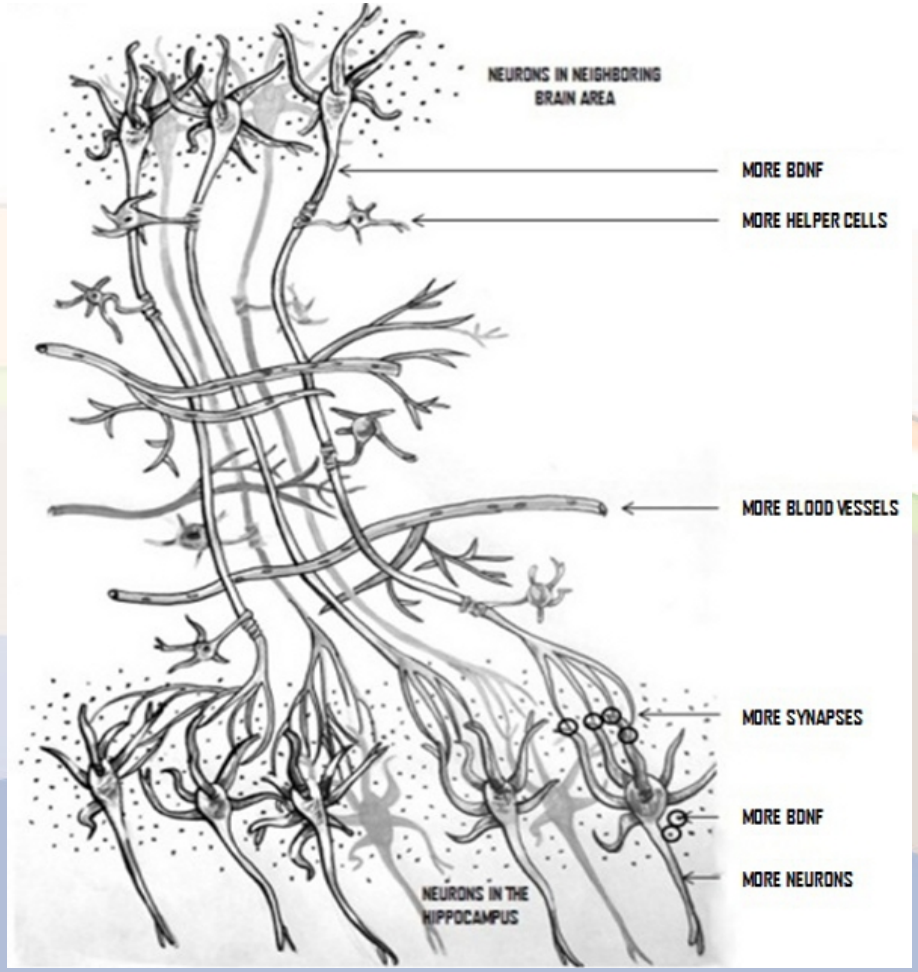


Four Ways to Build a Bigger Brain Reserve



Before and After





Neurogenesis in Hippocampus

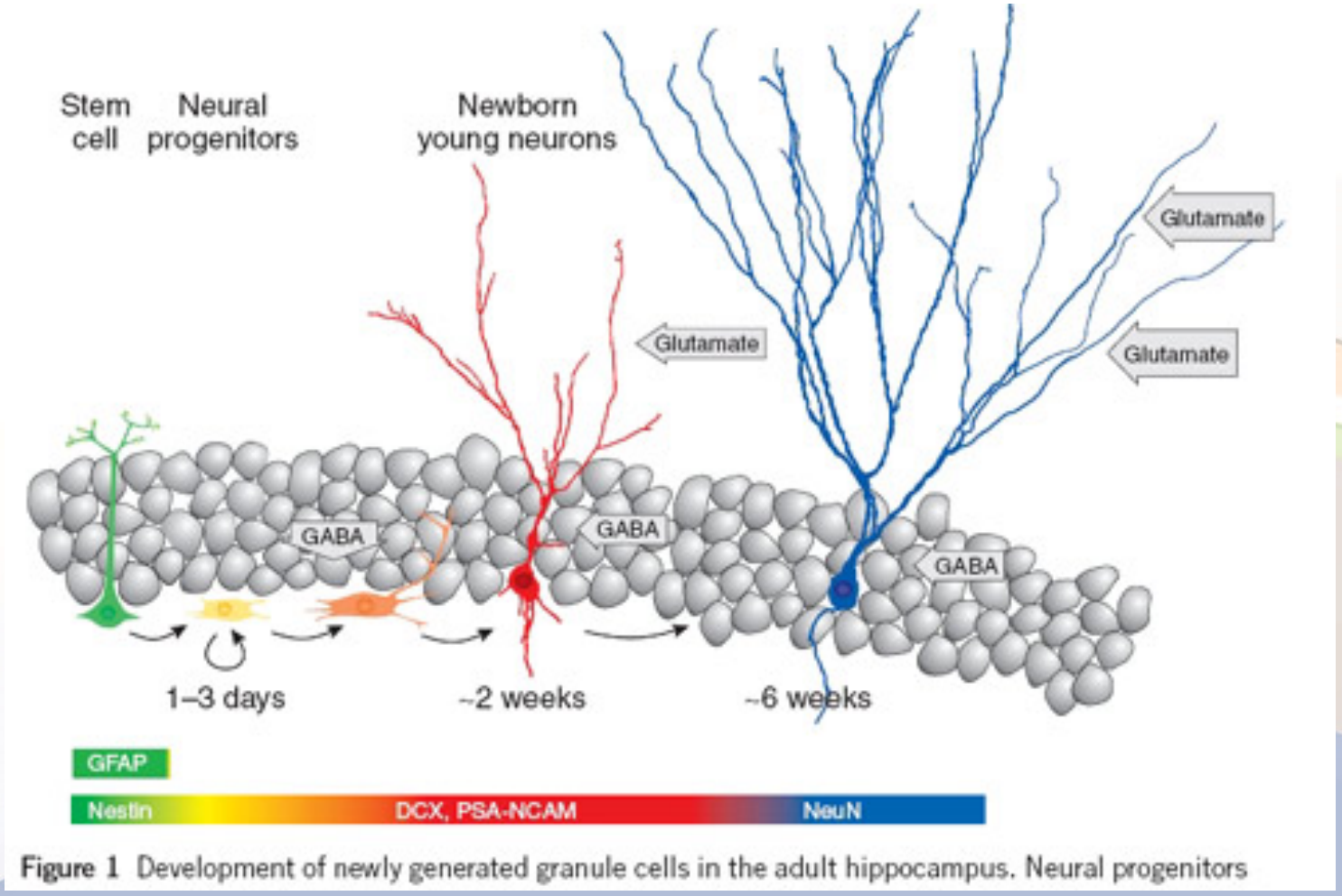
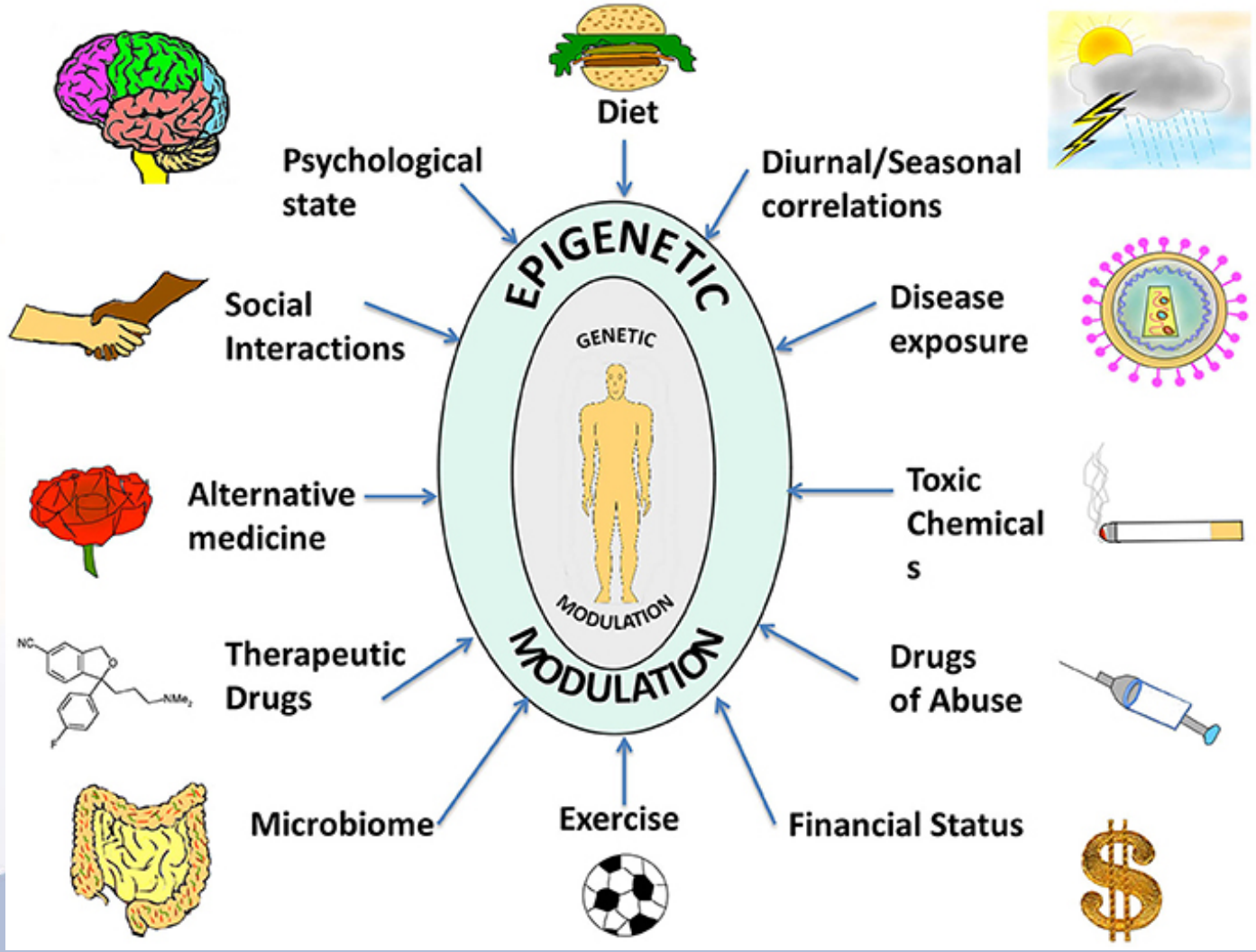


Figure 1 Development of newly generated granule cells in the adult hippocampus. Neural progenitors

Bischofberger, Nature Neuroscience, 2007

Epigenetics:
Factors That Modulate Your Genes



http://journal.frontiersin.org/article/10.3389/fcell.2014.00049/full

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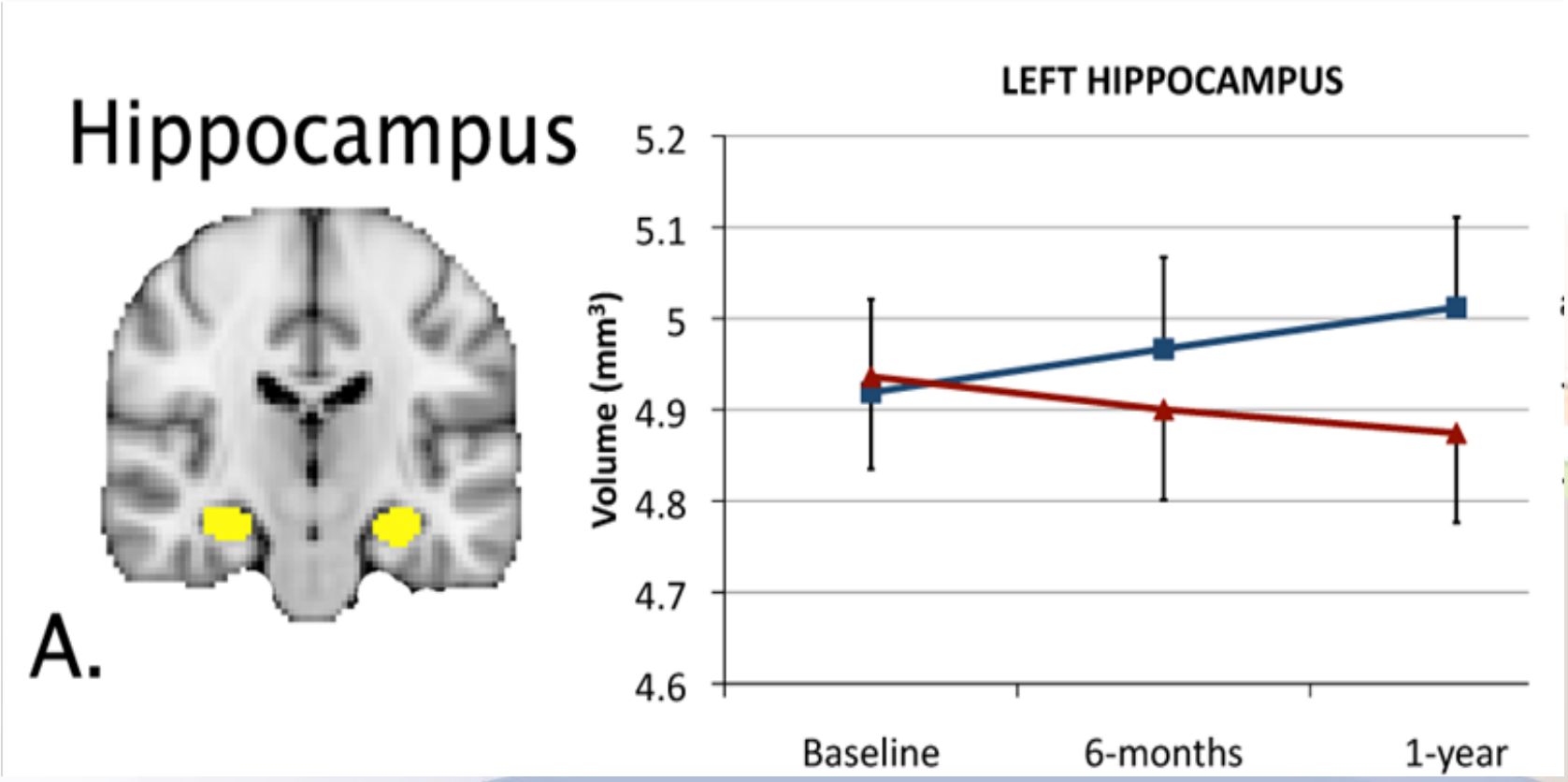
1. More Exercise, Bigger Hippocampus

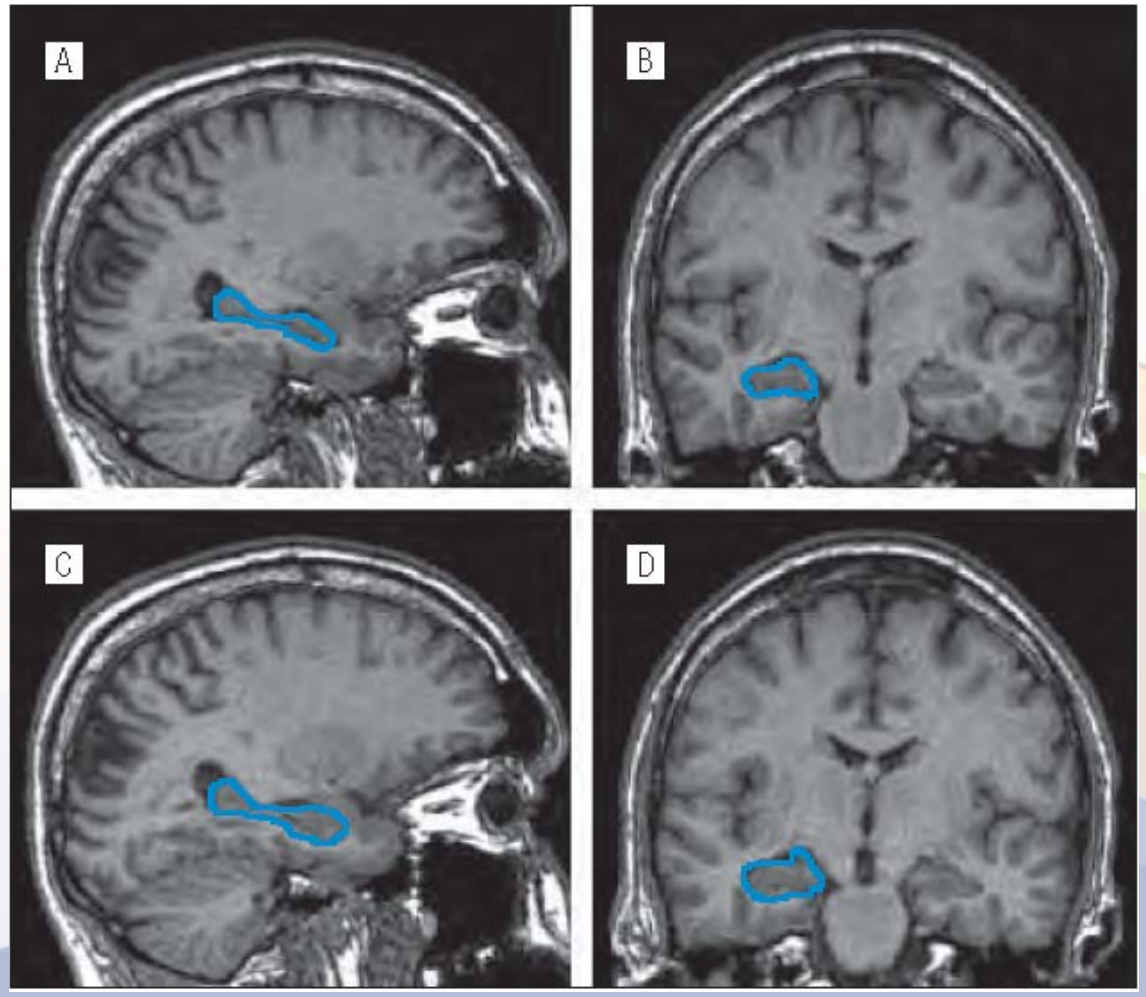


Erikson, PNAS 2011

More Exercise, Bigger Hippocampus, Even After 3 Months

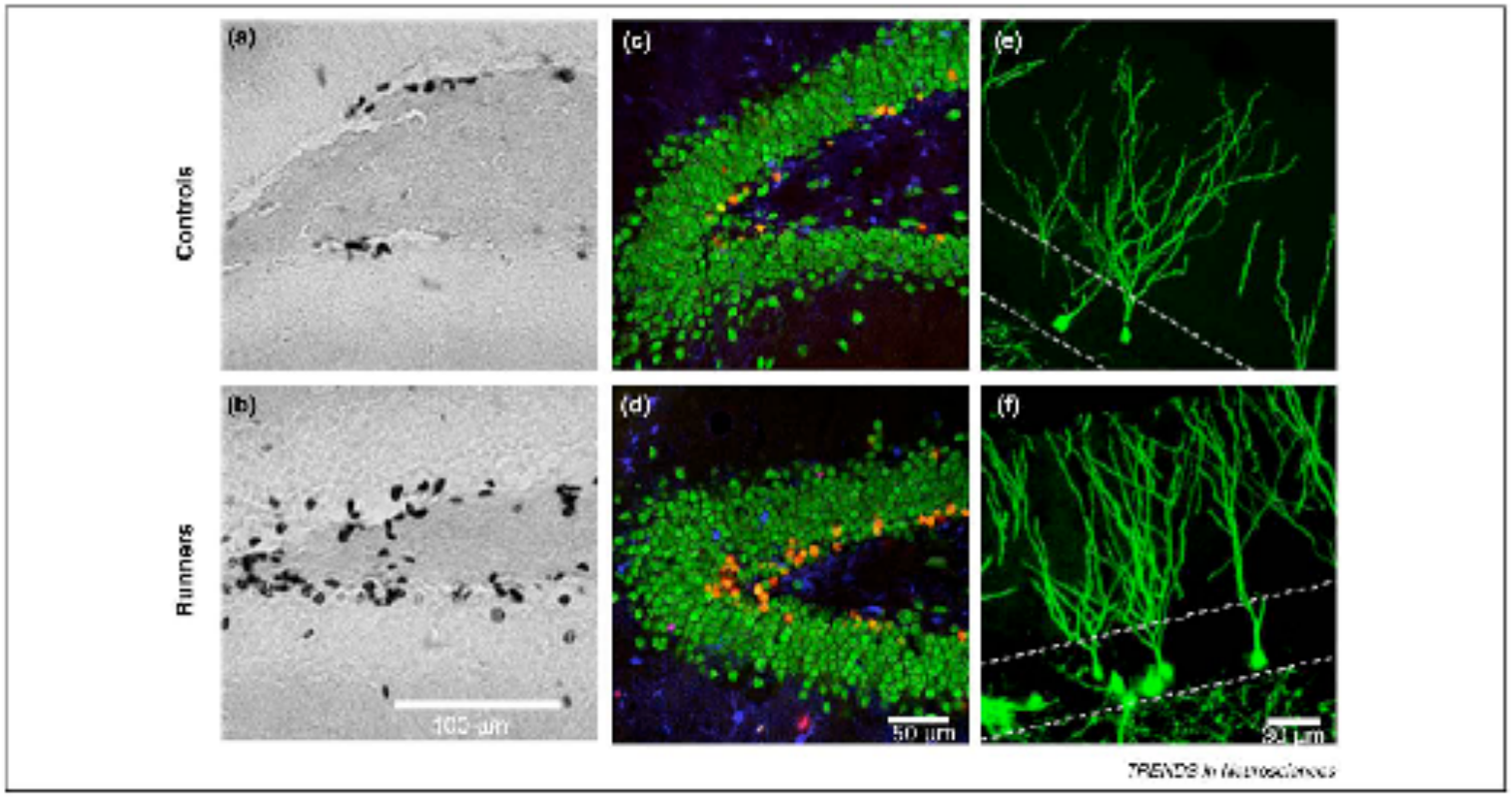
Before

After



Arch Gen Psychiatry, 2010

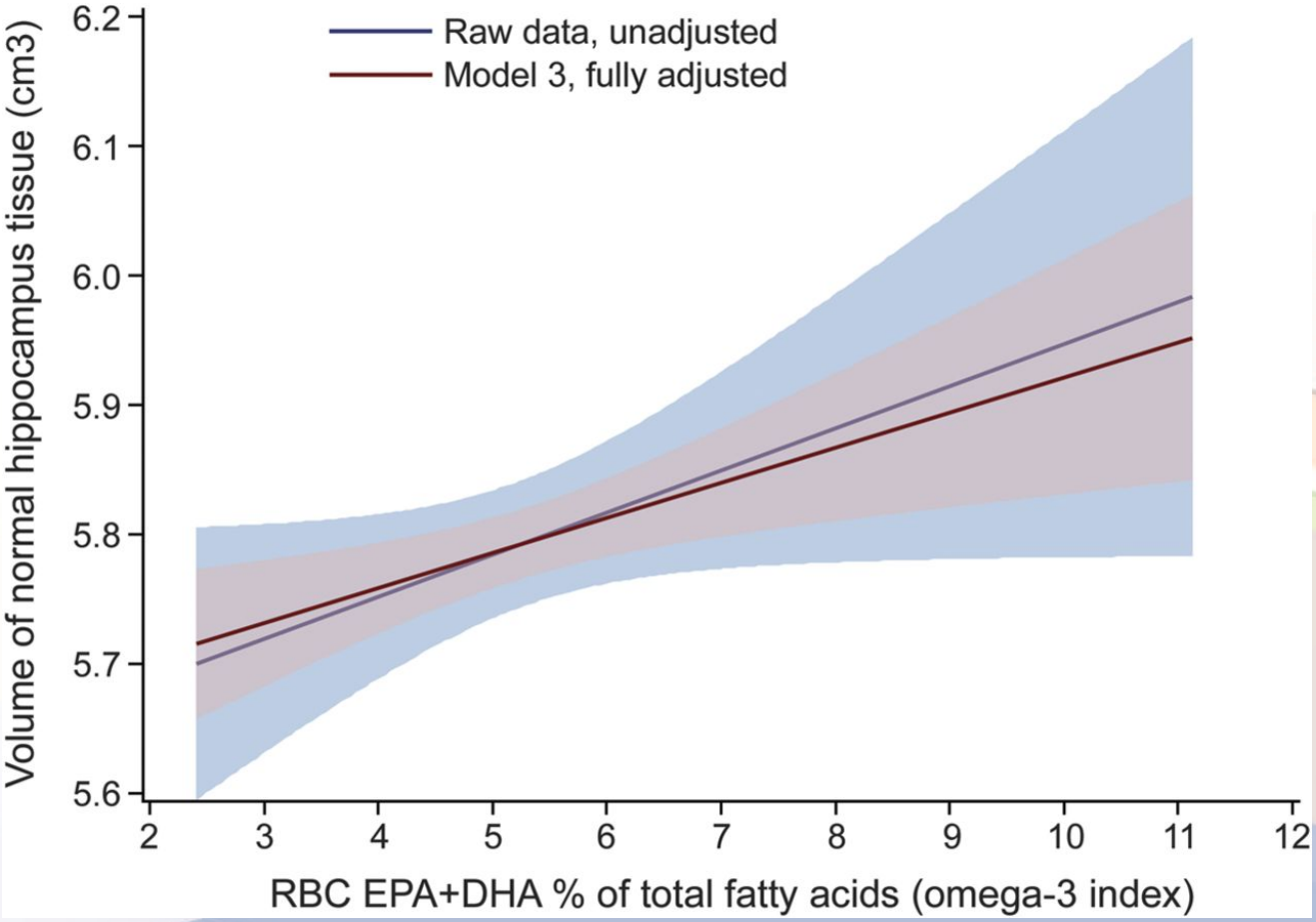
More Exercise: More Neurogenesis



Van Praag, Trends in Neurosciences, 2009

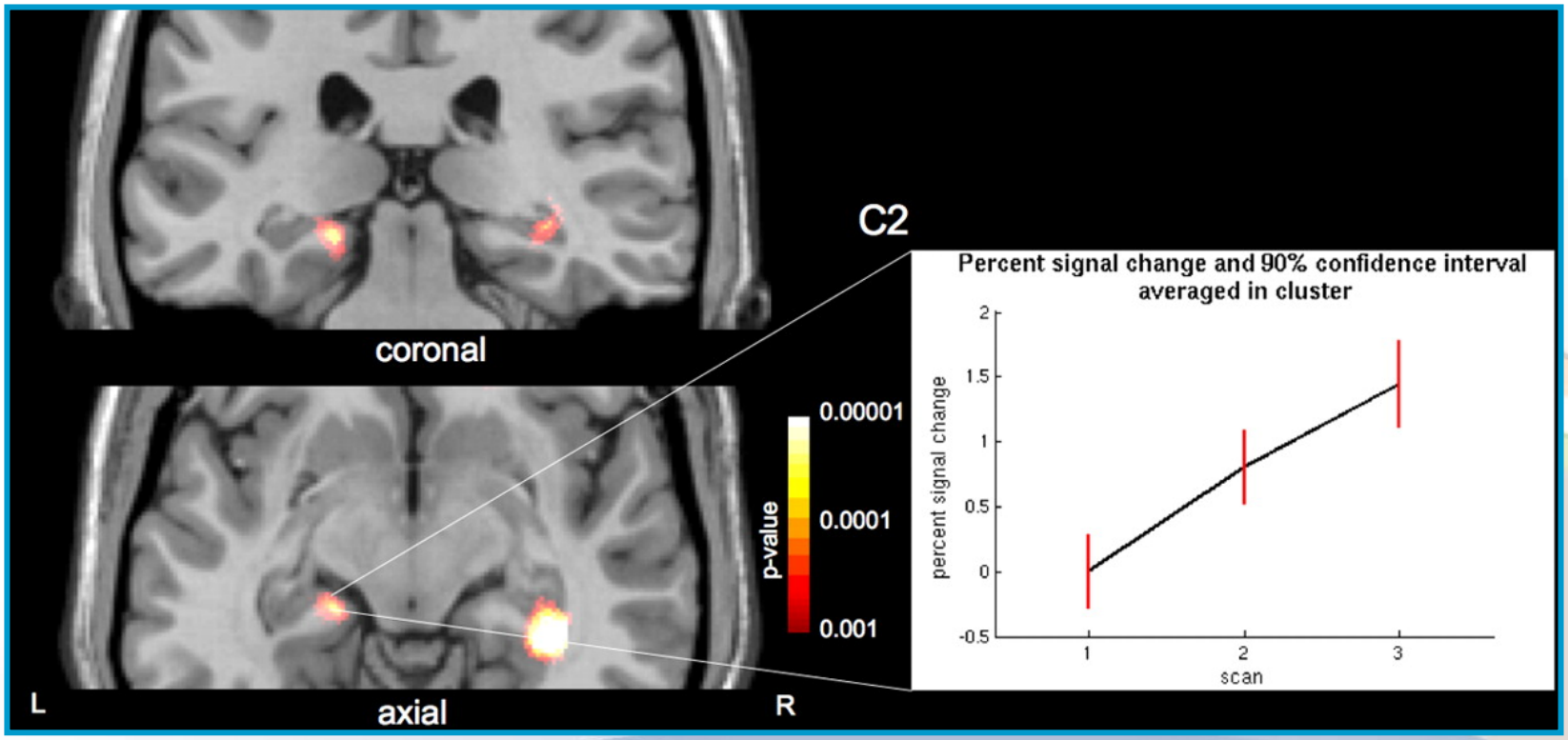
2. More Omega-3 Fatty Acids, Bigger Hippocampus

More Omega-3 Fatty Acids, Bigger Hippocampus



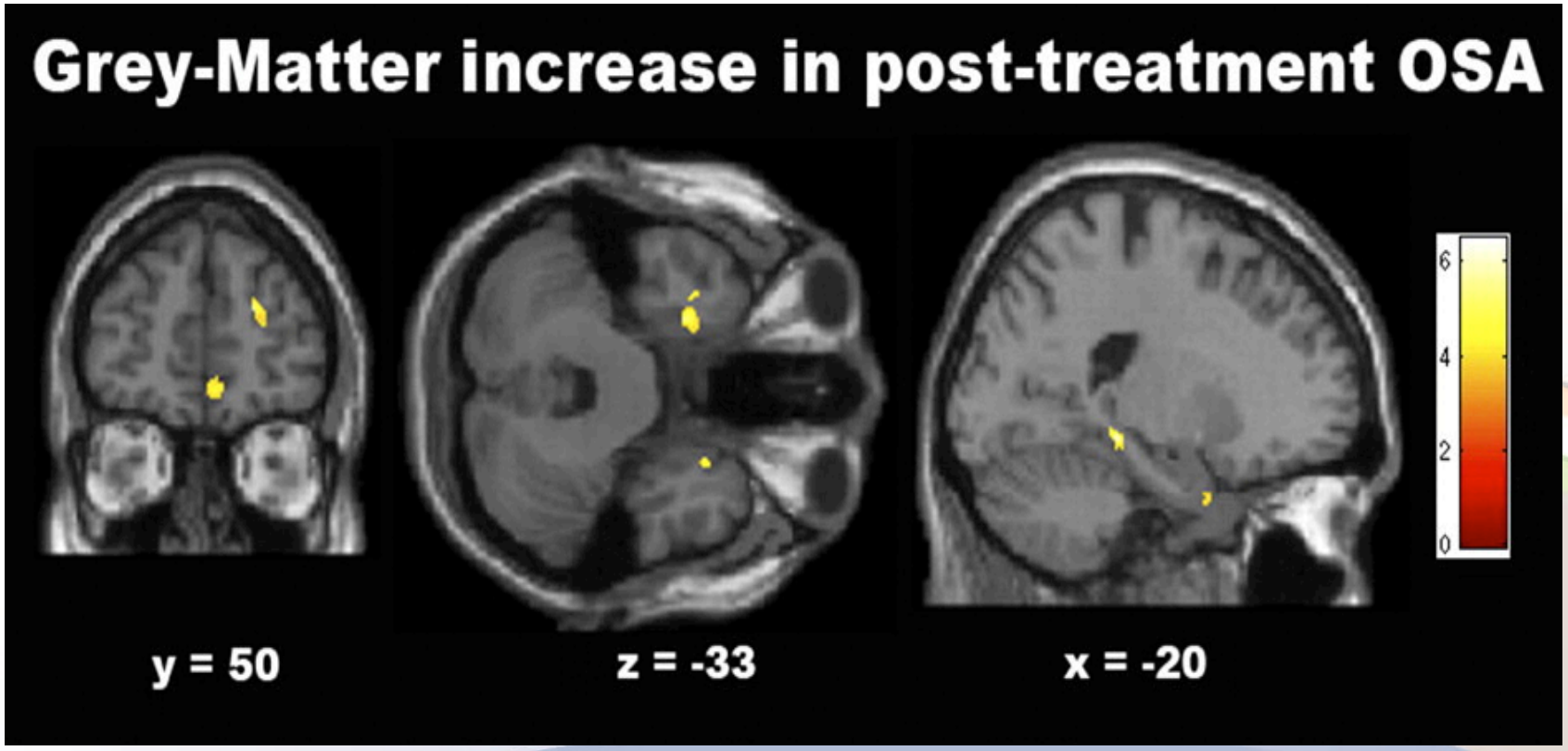
Pottala J V et al. Neurology 2014;82:435-442

3. More Learning, Bigger Hippocampus



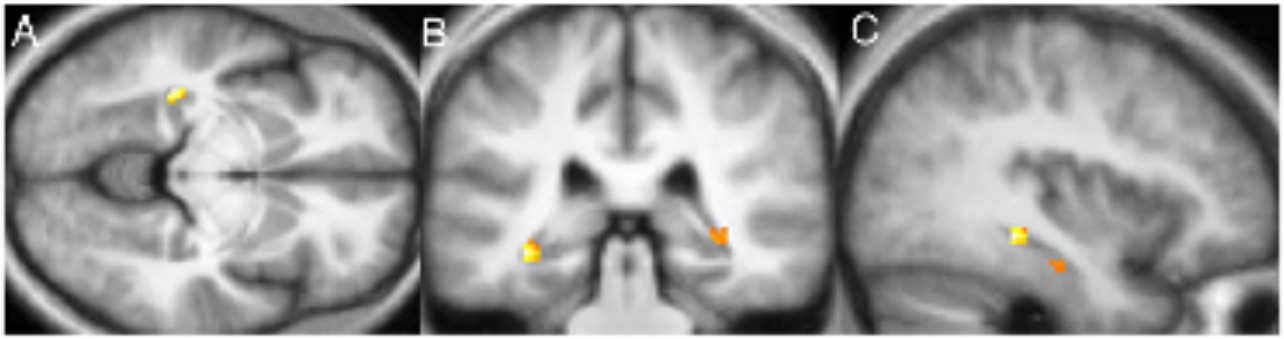
Draganski et al. J Neurosci 2006; 26:6314–7

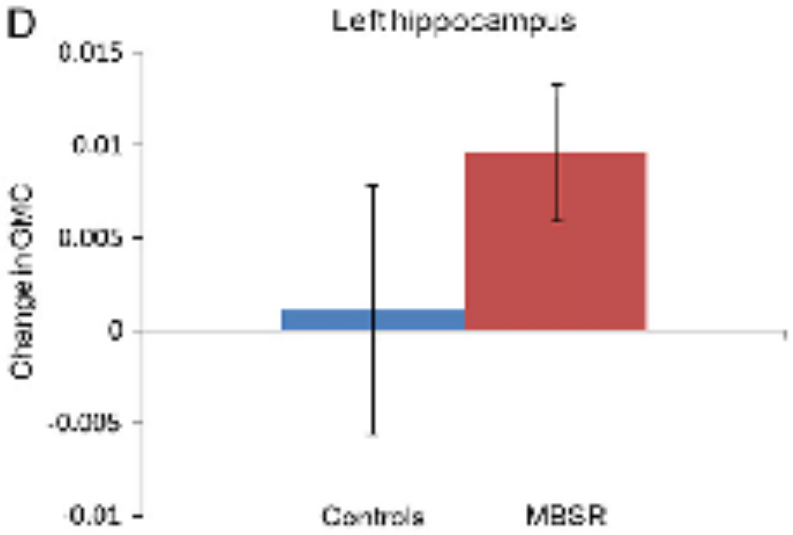
4. Better Sleep, Bigger Hippocampus



Canesa, American Journal of Respiratory Medicine, 2011

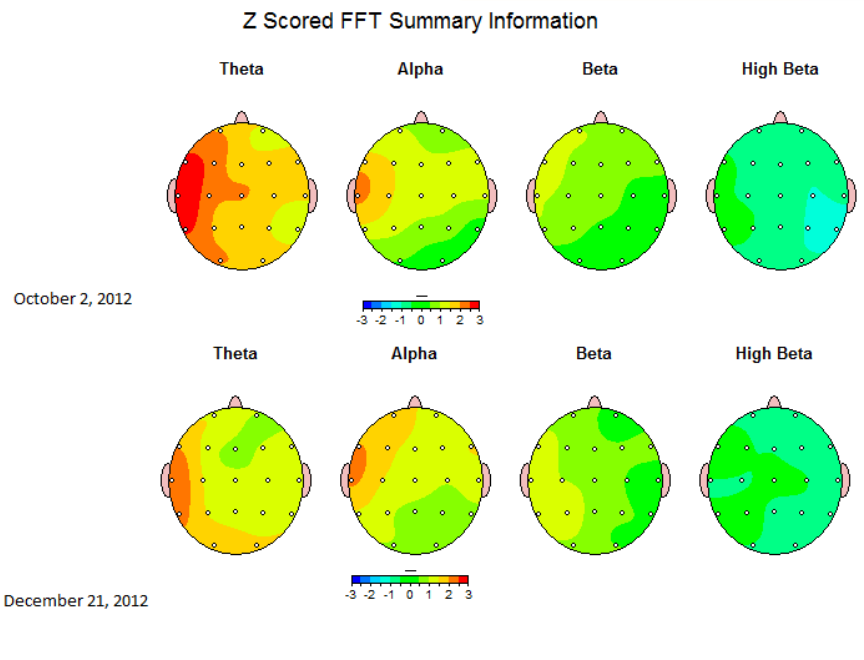
5. More Meditation, Bigger Hippocampus

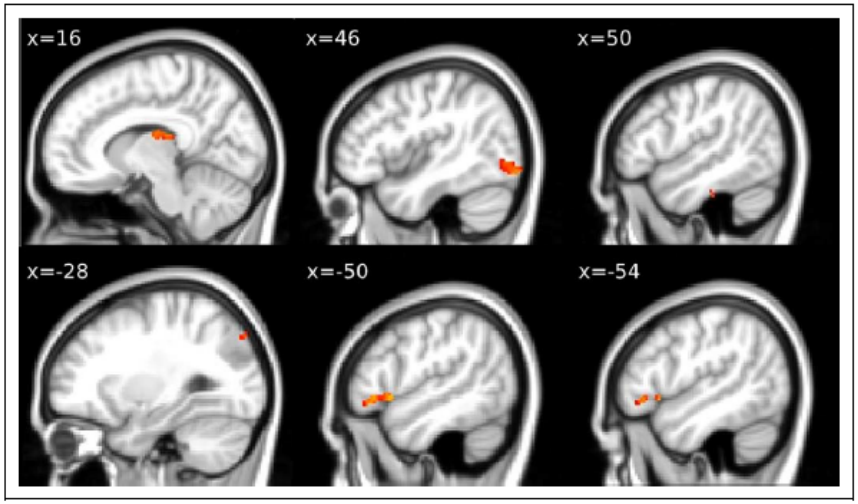




Holzel , Psychiatric Research, 2011

6. More Neurofeedback, Bigger Cortex





Ghaziri et al. Clin EEG Neurosci 2013; 44 (4) 265-72

Neurofeedback

- Performed by a certified EEG neurofeedback specialist
- Live EEG feedback is provided through auditory and visual responses to help the patient move brain activity towards an optimal state
- Benefits are long-lasting

Hippocampus Grows Bigger When You Start Early

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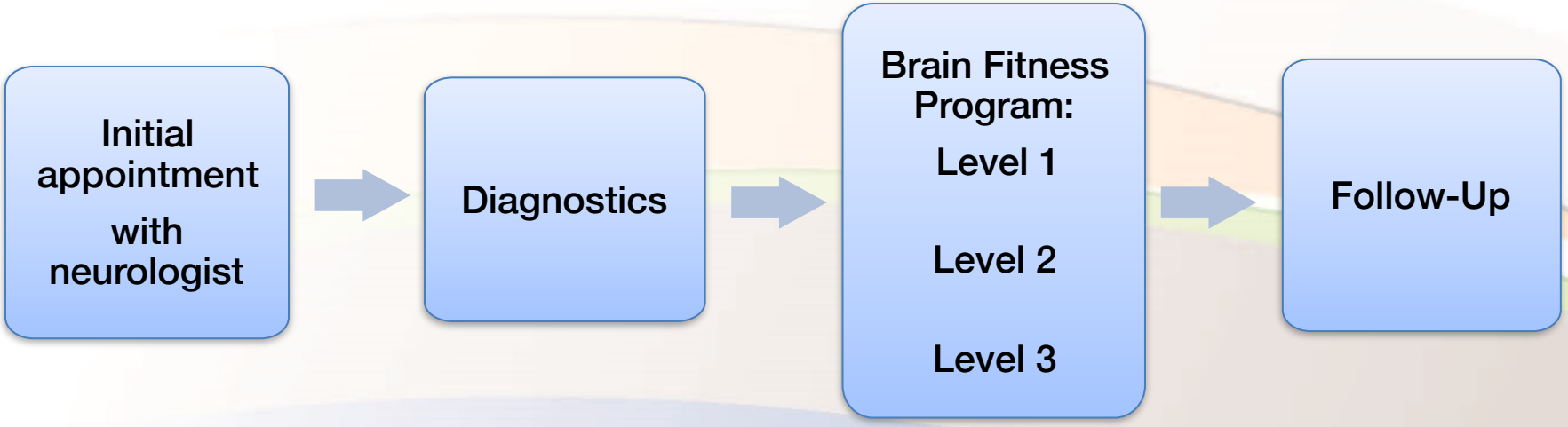
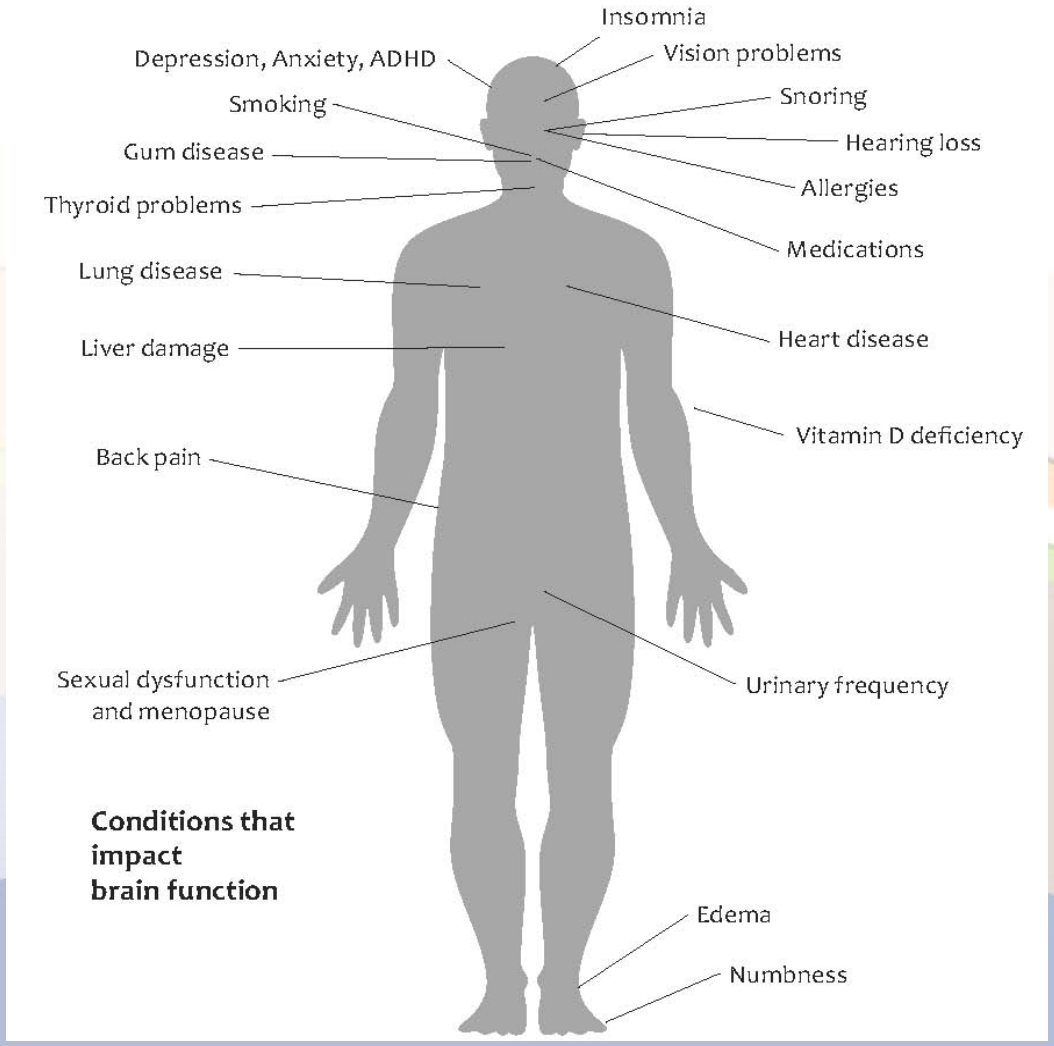
Brain Fitness Program: Overview



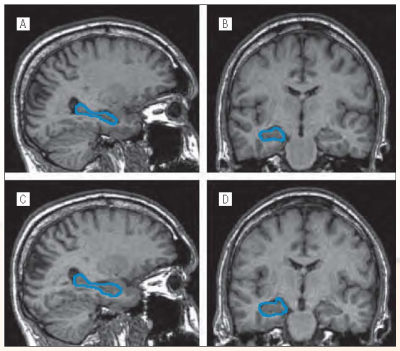
Brain Fitness Program: Initial Exam



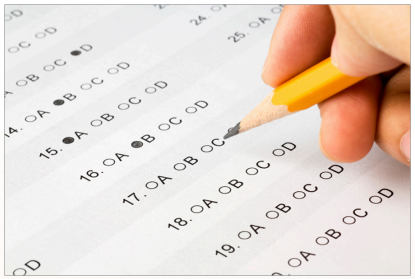
Brain Fitness Program: Comprehensive Diagnostic Tests

Cardiopulmonary Testing

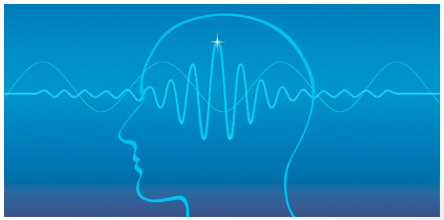
Brain MRI



Neurocognitive Evaluation



Brain Mapping qEEG



Carotid Ultrasound

Blood Test

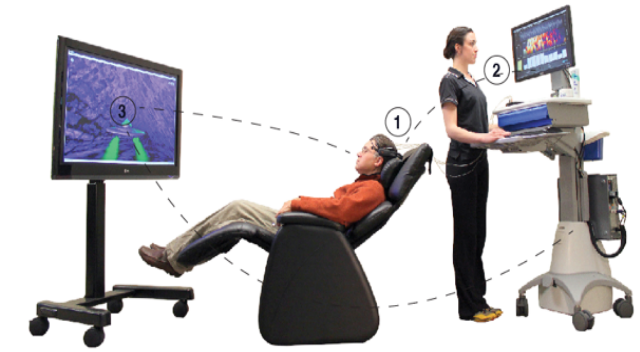
Sleep Health Assessment

Brain Fitness Program:
A Personalized Set of Interventions

Brain Coaching and Counseling

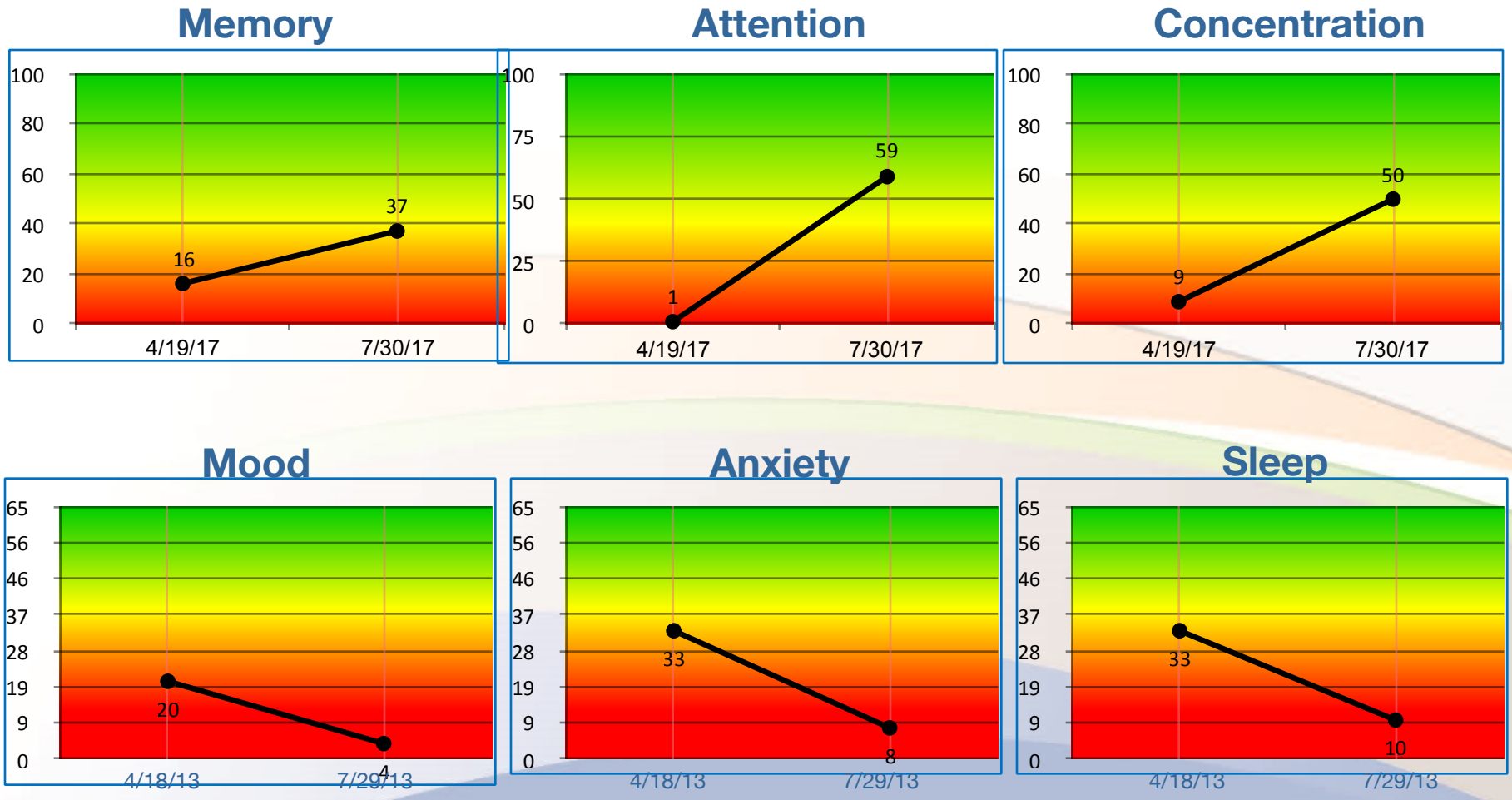
Cognitive Skills Training

Neurofeedback Training

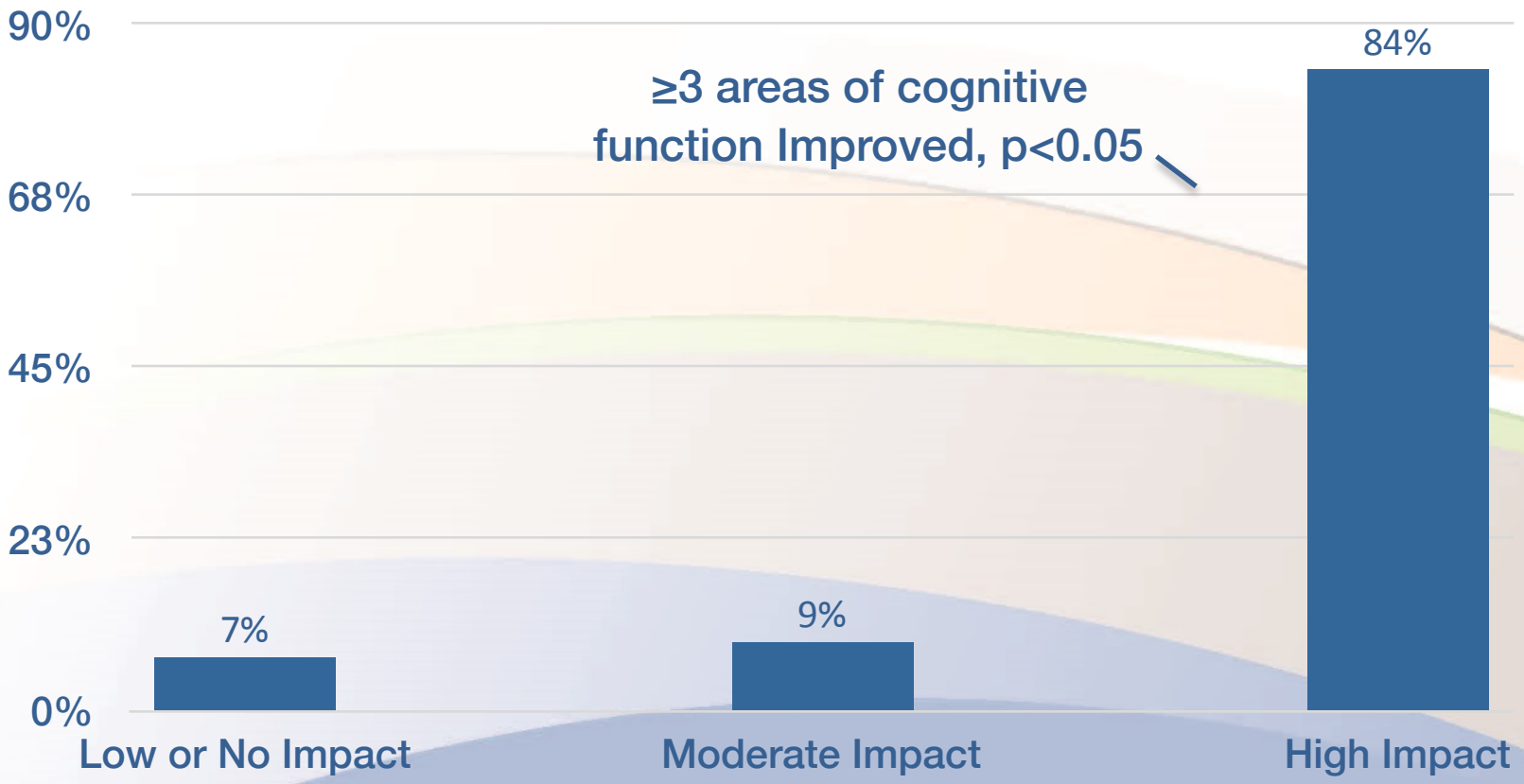


Weekly Monitoring

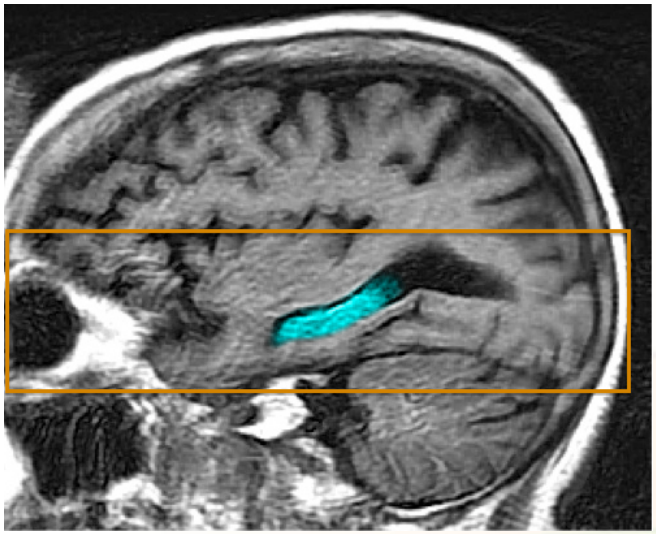
Brain Fitness Program:
One example: 69 year old with ?Alzheimer's



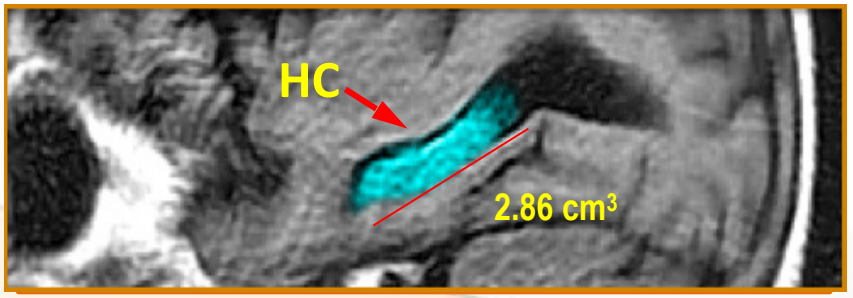
Brain Fitness Program:
Statistical Analysis of 127 Patients with MCI

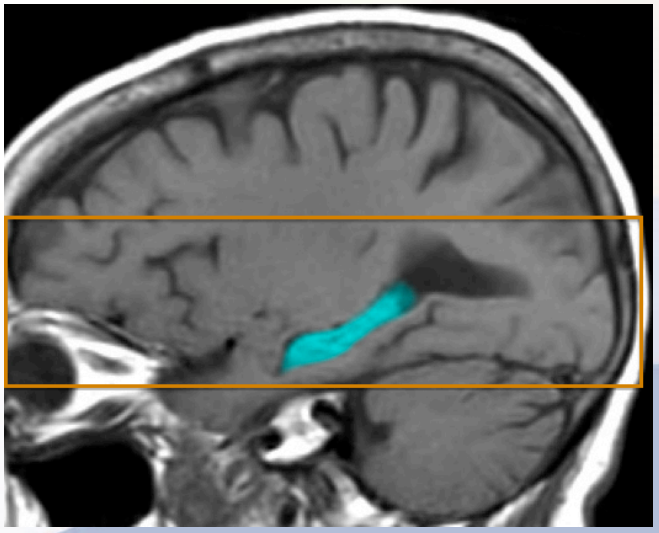


MRI Results

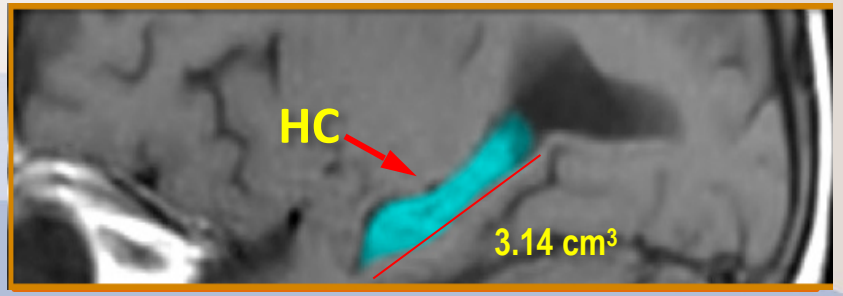


Before

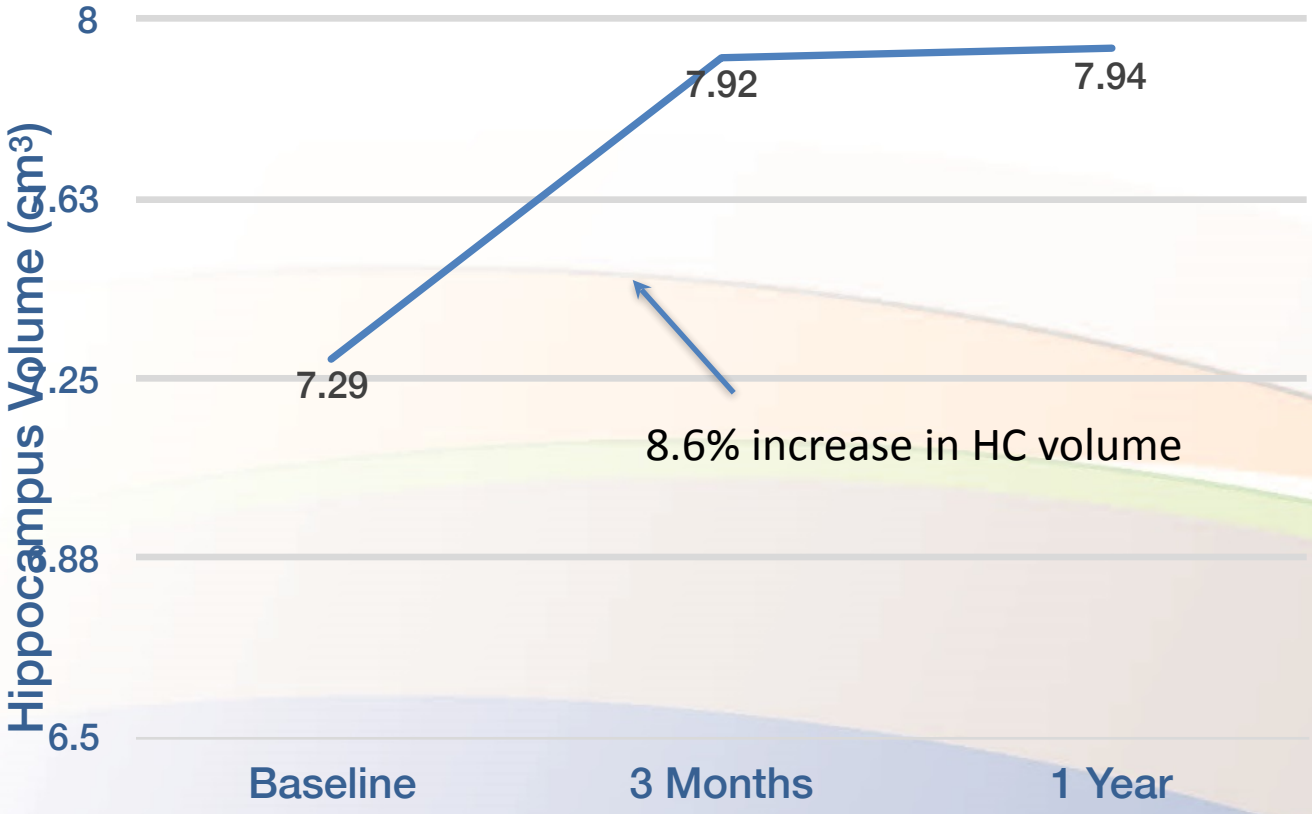




After



Sustained Benefits



Diabetes
Hypertension
Obesity
Sleep Apnea
Head Trauma
Genes
Stress

Brain-healthy Diet
Physical Fitness
Cognitive Stimulation
Brain Fitness Program

Summary

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THANK YOU