Brain Facts: The Adult Brain

- Weighs about 3-4 pounds
- Is about the size of a grapefruit
- 78% water, 10% fat, 8% protein
- 2% of body weight
- Consumes 20% of body’s energy
- Gets about 8 gallons of blood/hour
- Needs 8-12 glasses of water a day
- Uses one-fifth of body’s oxygen

Exercise Increases Levels of Key Neurotransmitters and Neurotrophic Factors

- Dopamine
- Serotonin
- Norepinephrine
- BDNF

30 minutes of Moderate to Vigorous Aerobic Activity

- Stimulates BDNF Causes Neurons to fire more efficiently
- Increases neurogenesis in the hippocampus
- Gets Oxygen and glucose to the brain faster
- Repetitive gross motor movement strengthens dendritic branching
- Reduces obesity
- Improves mood and elevates stress threshold
- Balances brain chemicals, hormones and system functions
- Prepares the Brain for Optimal Learning

Continuous Daily Rat Group-2, 4, 7, 14, 28, 90 days/Intermittent alternating day group 7, 14, 21, 28 days – 7 rats per exercise group and sedentary group

BDNF was assessed in the hippocampus using E-Max ELISA kit after each time segment

Daily access to running wheels produced the most rapid increase in BDNF levels. BDNF levels continued to rise even after 90 days. Similar patterns were seen with intermittent exercise, but at a slower rate

BDNF remained elevated for several days after exercise stops

No Change in BDNF with the sedentary group


-32 Rats in three age groups-2 months, 15 months, and 24 months

-Animals were assigned to an exercise or non-exercise cage, 5 per age group for 1, 2, 3, 4 week exercise-3 sedentary were analyzed for each exercise group

-Voluntary exercise was done on a running wheel

-Group sacrificed at the end of each time frame, brains removed, two hemispheres separated along midline; hippocampus, cerebellum and frontal cortex from each hemisphere of the brain was then microdissected and frozen. Blood was processed and serum collected.

-BDNF levels for the exercising groups increased proportionately with number of weeks of exercise, younger rats BDNF levels were somewhat higher for each group tested


Subjects: 15 subjects, age 24-26, physically active, adequate health, no significant medical conditions

-3 tests on stationary cycle-1 GXT & 2 endurance

-BDNF levels were measured with a blood draw before and after activity

-significant increase in BDNF levels with endurance exercise and in the GXT

-STROOP cognitive test scores also increased after activity


Exercise Enhances Learning and Hippocampal Neurogenesis in Aged Mice Praag et al. 2005

- Rats sedentary to 19 months-15 young mice (3 months of age) and 18 old mice (19 months of age)

- Voluntary wheel running for one month on the Morris water maze

- Brains were injected with green fluorescein protein

- Average distance of runs was comparable between the two groups

- Neurogenesis occurred in both groups - a 49.9% increase in young mice and a 25% increase in older mice


This study was undertaken to investigate whether neurogenesis occurs in the adult human brain, specifically the hippocampus. Human brain tissue was obtained postmortem from patients who had been treated with thymidine analog, bromodeoxyuridine-which identifies new neurons. Results indicated that the human hippocampus retains its ability to generate neurons throughout life.

Collardeau et al. performed numerous studies indicating that cognitive functioning improves after prolonged exercise. It is expected that 20 minutes of aerobic exercise decreases anxiety and increases glucose and oxygen levels in the brain.

Exercise Prepares the Brain for Optimal Learning

- Heightens ability of systems to function more efficiently and effectively.
- Enhances the ability of cells to connect.
- Promotes new cell growth.

Exercise Improves Learning on Three Levels

- Optimizes mind-set to improve alertness, attention and motivation
- Prepares and encourages nerve cells to bind together
- Spurs the development of new nerve cells

Exercise and Cognition

- Causes nerve cells multiply—nerve connections are strengthened, neurons are more protected from harm
- Exercise increases neuronal connections
- Exercises increase the number of capillaries surrounding the neurons
- Exercise strengthens the cerebellum
- Exercise strengthens the corpus callosum
- Increases levels of the neurotransmitters dopamine, seratonin, norepinephrine and Brain Derived Neurotrophic Factor—BDNF

Exercise and Academic Achievement

- Students in grade 5 (353,000), grade 7 (322,000), and nine (279,000)
- Research Tools: Fitnessgram and SAT9
- Key Findings
  - Higher SAT scores were associated with higher levels of fitness at all levels
  - The relationship between academic achievement and fitness was greater in math and reading, particularly at higher fitness levels
  - Students who met minimum fitness levels in three or more physical fitness areas showed the greatest academic gains at all three grade levels
  - Females showed higher academic achievement than males particularly at higher fitness levels.

Basal Ganglia Volume Associated with Aerobic Fitness in Preadolescent Children Chaddock, L., et al. 2010 Pub Med

- Higher aerobic fitness levels are associated with greater hippocampal volumes, superior performance on tasks of attentional and interference control, and elevated event-related brain potential indices of executive function. The present study used magnetic resonance imaging to investigate if higher-fit and lower-fit 9 and 10 year old children exhibited differential brain volumes. The results indicated that higher fit children showed larger basal ganglia volume, which affects cognitive processes and control. MRI scans also showed an increase in hippocampus density in more aerobically fit children.
When We Exercise

- Attention Increases
- Adrenaline Increases
- Blood Flow Increases
- Motivation Increases
- Brain Chemicals Balance
- Hormones Balance
- Neurotransmitters Balance

The Brain Goes Into a Homeostatic State of Balance

Sommerford, C. 2009

When We Exercise We Achieve

- Increased Focus
- Stress Reduction
- Information Retention
- Memory Retrieval
- Change of State Learning

Summerford,


- Study participants were 20 9-year-olds (eleven girls and nine boys) who performed a series of stimulus-discrimination tests known as flanker tests to assess inhibitory control.
- On one day students were tested following a 20 minute rest period and on another day after a 20 minute treadmill walk.
- During testing students were outfitted with an electrode cap to measure EEG activity.
- After a bout of walking students performed better on the flanker tests. They had higher rate of accuracy, especially when the task was more difficult. Following the walking children had a larger P3 amplitude suggesting that they are better able to pay attention especially under difficult conditions of the flanker test. They are better able to gate out noise to select a correct stimulus.
- Researchers Charles Hillman and Darla Castelli


- 259 3rd and 5th grade students
- Fitnesgram and ISAT (State test for Illinois), Prairie State Achievement, and Illinois Measure of Annual Growth in English
- Children who displayed higher levels of aerobic fitness had higher standardized test scores in reading and math regardless of age, gender or poverty index
- The higher the BMI the lower the standardized test score
- Muscle strength and flexibility were observed to be unrelated in this study


- Stress causes atrophy and cell loss in limbic structures, particularly the hippocampus.
- Stress causes a rapid down-regulation of BDNF and vascular endothelial growth factor (VEGF).
- Stress decreases neurogenesis due to increase in cortisol levels and decrease in BDNF levels.
- Neuronal atrophy occurs with stress and is evident in depressed individuals.
- Volume of the hippocampus is decreased in depressed individuals.
- Postmortem studies demonstrated low BDNF levels in the hippocampus and pre-frontal cortex of depressed suicide subjects.
- Serum studies also show low BDNF levels in depressed patients


- Antidepressant medication increases BDNF, VEGF, and serotonin and norepinephrine uptake inhibitors.
- Antidepressant medication increases neurogenesis.
- Exercise increases BDNF, VEGF, and serotonin and norepinephrine uptake inhibitors.
- Exercise improves mood and decreases learned helplessness.
- Dietary regulation plays a role in balancing neurotrophic factors and hormones like insulin that affect body weight.
Guided Relaxation

Yoga Breathing
Three Part Breathing
Deep Sinking Breathing
Mind Calming Hook-Ups
Lighten the Brain’s Heavy Load
Stress Sweep
The Wheel
Seated Cat Cow
Seated Sunflowers
Head to Toe Release and Relax

Bartholomew, J. et al. (2005). Effects of Acute Exercise on Mood and Well-Being of Patients of Patients with Major Depressive Disorder

• Purpose: to determine if a single bout of moderate-intensity aerobic exercise would improve mood and well-being in 40 (15 male, 25 female) individuals receiving treatment for major depressive disorder

• Method: Participants were randomly assigned to exercise 60-70% of age-predicted max heart rate for 30 minutes or to a 30 minute quiet rest. Participants completed both the Profile of Mood States and the Subjective Exercise Experiences Scale as indicators of mood 5 minutes before and at 5, 30 and 60 minutes after their experimental condition.

• Results: Both groups reported similar reductions in measure of psychological distress, depression, confusion, fatigue, tension and anger. Only the exercise group reported a significant increase in positive well-being and vigor.

Brohman-Fulks, J. (SPARK)

• Subjects: 54 college students with generalized anxiety disorder who had elevated anxiety sensitivity scores and who exercised less than once a week.

• Divided subjects in two groups—one group ran on treadmills at an intensity level of 60-90% of max heart rate, the second walked on treadmills at a pace of one mile and hour, approximately 50% of max heart rate.

• Both regimens reduced anxiety sensitivity but the high intensity exercise worked more quickly and effectively.

Regular Exercise for Management of Stress, Anxiety, Depression, ADHD

• Increases self-efficacy
• Develops a sense of mastery
• Provides distraction from negative thinking
• Improves self-concept

Research Update on Effects of Exercise on Hormonal Changes

PMS
23 premenopausal women: 12 ran (70-85% max) 30 minutes 3X a week and 11 women strength trained 3X a week. Both did a warm up and cool down. Both groups had an improvement in physical symptoms. Runners felt better on 18 of 23 measures; the most significant depression, irritability, and concentration. Blumenthal (p196 SPARK)

Pregnancy
2007 Study in England evaluated the effects of a single bout of exercise on mood of 66 healthy pregnant women. Four groups treadmill walk, swim, arts and crafts class or maintained same routine. The two exercise groups improved moods. Exercise often decreases with pregnancy: survey suggest that 60% of pregnant women are inactive.

Menopause
Numerous studies have found that physically active women self-report fewer menopausal symptoms

Research on Brain Health and Aging

• Exercise increases BDNF which gives neural synapses the tools they need to take information in, process it, associate it, remember it and use it (Cotman, 1995)

• Kramer’s study of people ranging from 60-79 years of age doing aerobic exercise found growth in volume of the frontal and temporal lobes of the brain after 6 months.

• People learn vocabulary words 20% faster following exercise than they did before exercise (Ratey, 2008)

• Obese people are twice as likely to suffer from dementia (Ratey, 2008)

• People with heart disease are twice as likely to suffer from dementia (Ratey, 2008)

• People with diabetes have a 65% higher risk of developing dementia (Ratey, 2008)

• High cholesterol increases risk of dementia by 43% (Ratey, 2008)
Exercise and the Aging Brain


- Three in four men who reach age 80 years undergo successful mental health aging. Factors associated with successful mental aging include education and lifestyle behaviors such as physical activity. Almeida, O. (2006).

- Strength training can benefit memory among older adults when using higher resistance levels. Lachman, ME. Et al (2006).

Seven Key Ways Exercise Improves the Mind-Body Connection

- Changes Brain Circuitry
- Balances Hormones
- Balances Neurotransmitters
- Changes Levels of Neurotrophic Factors
- Improves Resilience
- Increases Stress Threshold
- Develops Self-Control
- Provides a Positive Focus