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Exercise and the Brain
Honors Program

MENS SANA IN CORPORE SANO

a healthy mind is a healthy body

Exercise's Effect on the Brain

- Neurotransmitters and exercise
 - 5-HT(serotonin) dopamine, epinephrine
- Transient Hypofrontality Theory
 - What it is
 - Why Exercise utilizes it
 - 'The Runners High'
 - How it effects disease
 - I.e. Depression
- BDNF
 - What is it
 - Why Exercise affects it
 - How it effects diseases
 - Alzheimer's

Neurotransmitters

- What is a neurotransmitter?
- How they Work

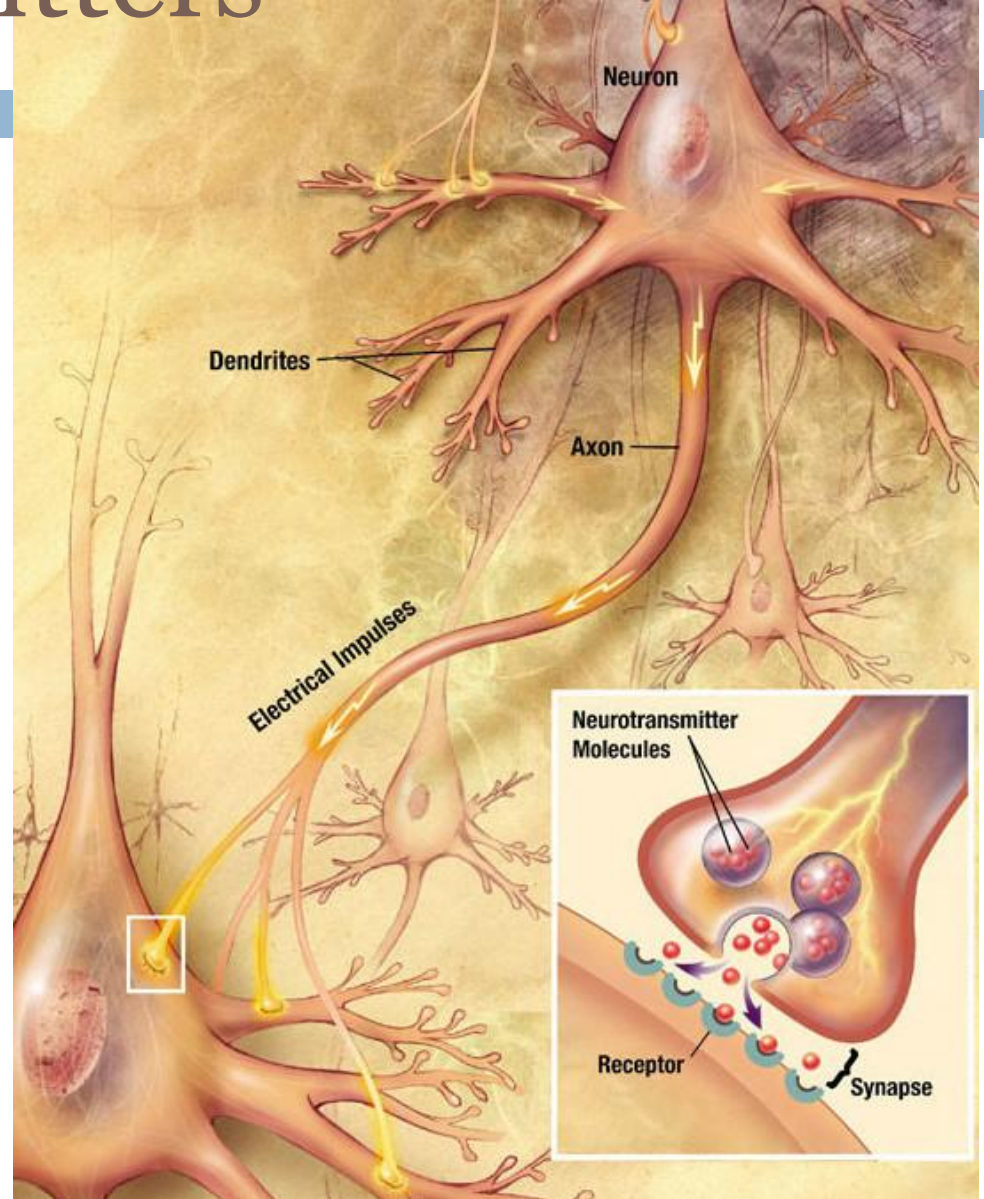


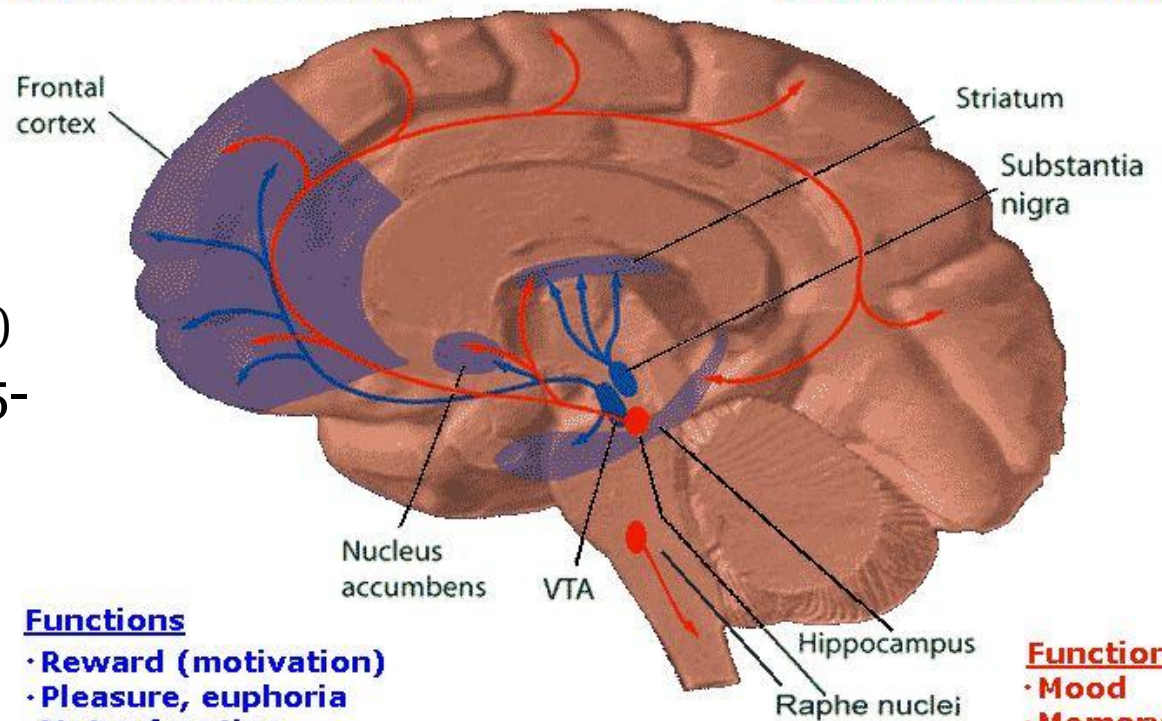
Image from Boundless.com

Neurotransmitters

- Dopamine
- Adrenaline
 - (or epinephrine)
- Noradrenaline
 - (or norepinephrine)
- 5-hydroxytryptamine (5-HT)
 - (serotonin)

Dopamine Pathways

Serotonin Pathways



Functions

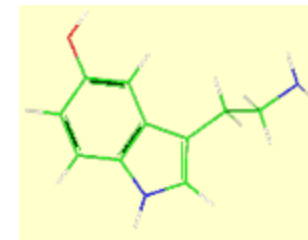
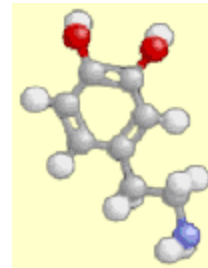
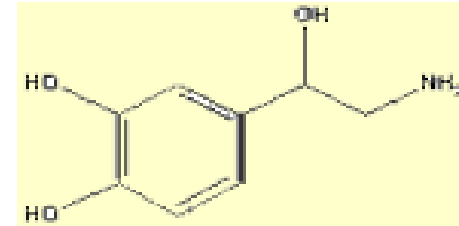
- Reward (motivation)
- Pleasure, euphoria
- Motor function (fine tuning)
- Compulsion
- Perseveration

Functions

- Mood
- Memory processing
- Sleep
- Cognition

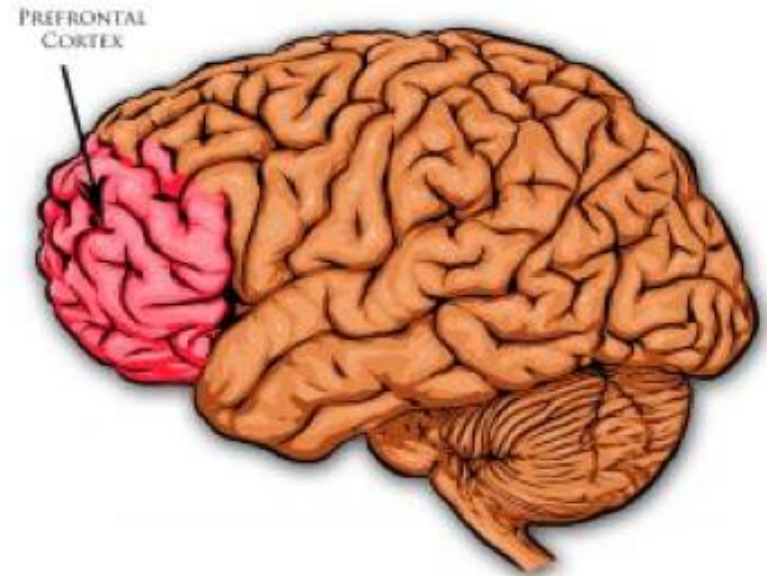
Exercise and Neurotransmitters or the neuroendocrinological connection

- Adrenaline/
noradrenaline
 - ▣ Important to glycolysis
 - ▣ alertness
- Dopamine
- 5-Ht
- Animal models have
shown increase in the
brain



The Transient Hypofrontality Theory

- From the cerebral cortex to the cerebellum
- The prefrontal Cortex
 - ▣ Its function
- Down regulation of the higher order functions
 - ▣ I.e. holistic mental approach
 - Frith & Dolan



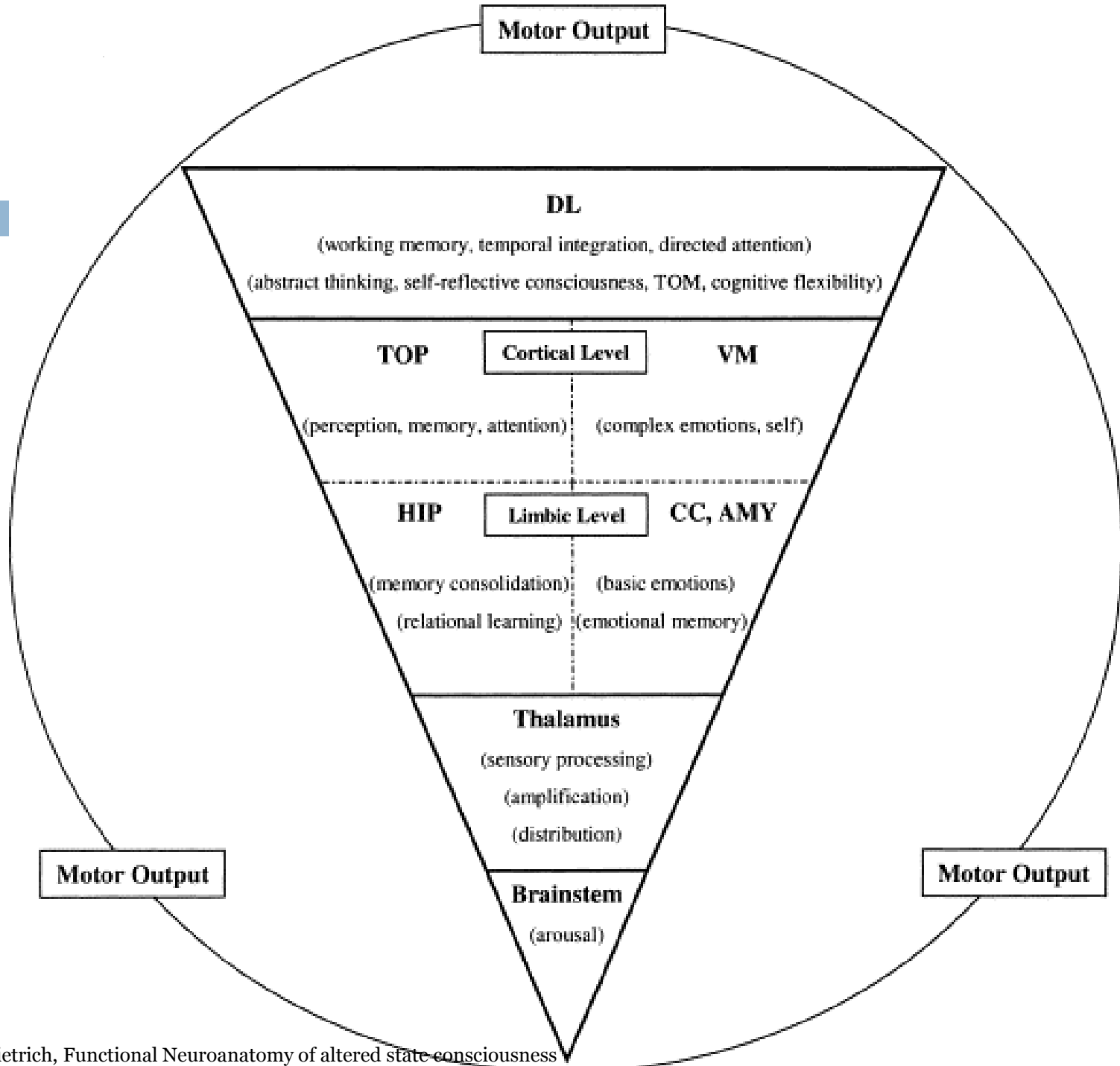


Image from: Dietrich, Functional Neuroanatomy of altered state consciousness

Fundamental Principles of Neuroscience

1. “The brain has a finite energy supply
2. Physical motion is ...an extremely demanding task
3. Information processing in the brain is based on competitive interaction among neurons”
 - Arne Dietrich

Altered states of Consciousness

- 6 types of altered consciousness
- Transient deregulation
 - ▣ The Runners High
 - ▣ Chronic vs. acute exercise



Exercise, THT and Depression

Depression

- Hyperactivity/hypermetabolism in dorsolateral prefrontal cortex and ventromedial aspect
- Hyperactivity in hypothalamic-pituitary-adrenal (in Major Depression)
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- Overemphasis of negative events
- Loss of cognitive flexibility

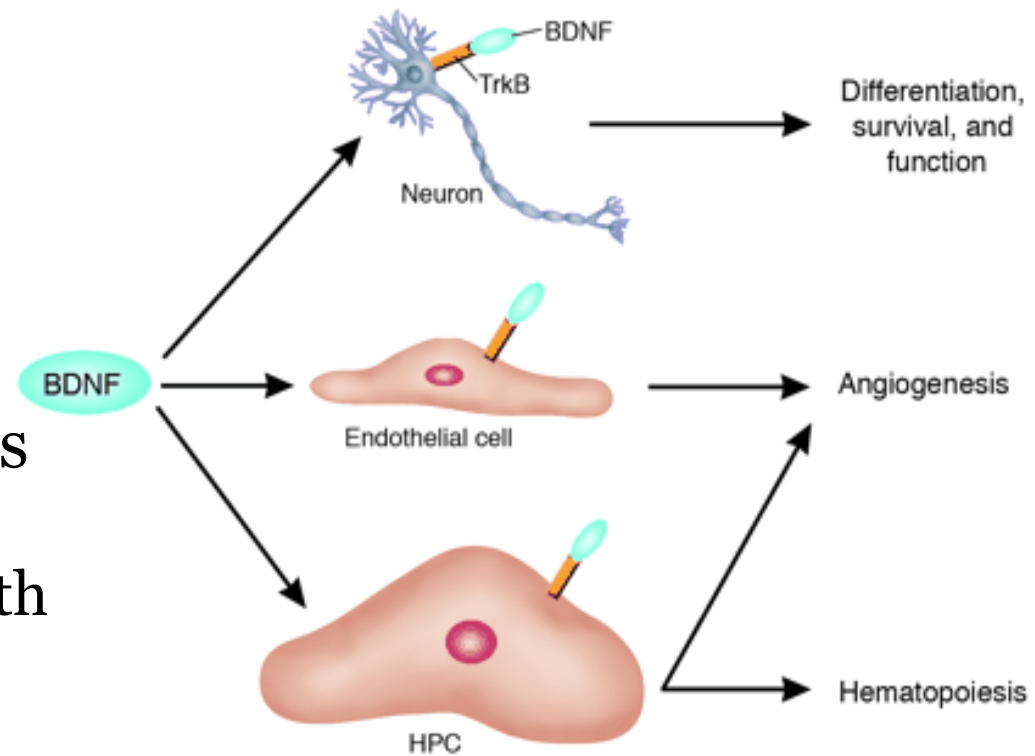
How exercise can help

- Down-regulates these areas
 - Normalizes/ returns frontal cortex to homeostasis
 - Provides 'brain break'
 - Neurogenesis
- (discussed next)



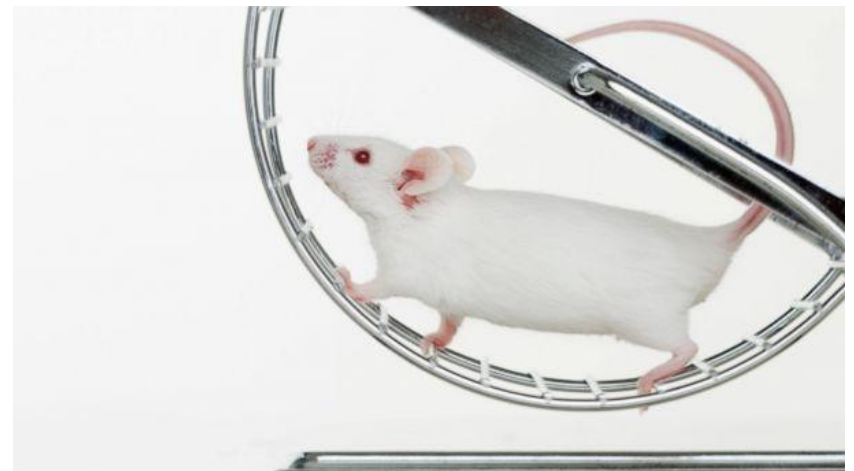
Brain Derived Neurotrophic Factor BDNF

- Neurotrophic Factor
 - ▣ Induces survival and growth of neurons and neural cells
 - ▣ Growth factor/protein
 - ▣ Vital to memory
 - ▣ Can cause neurogenesis
 - Mice born with out this factor die soon after birth and have limited neural pathways



Exercise and BDNF

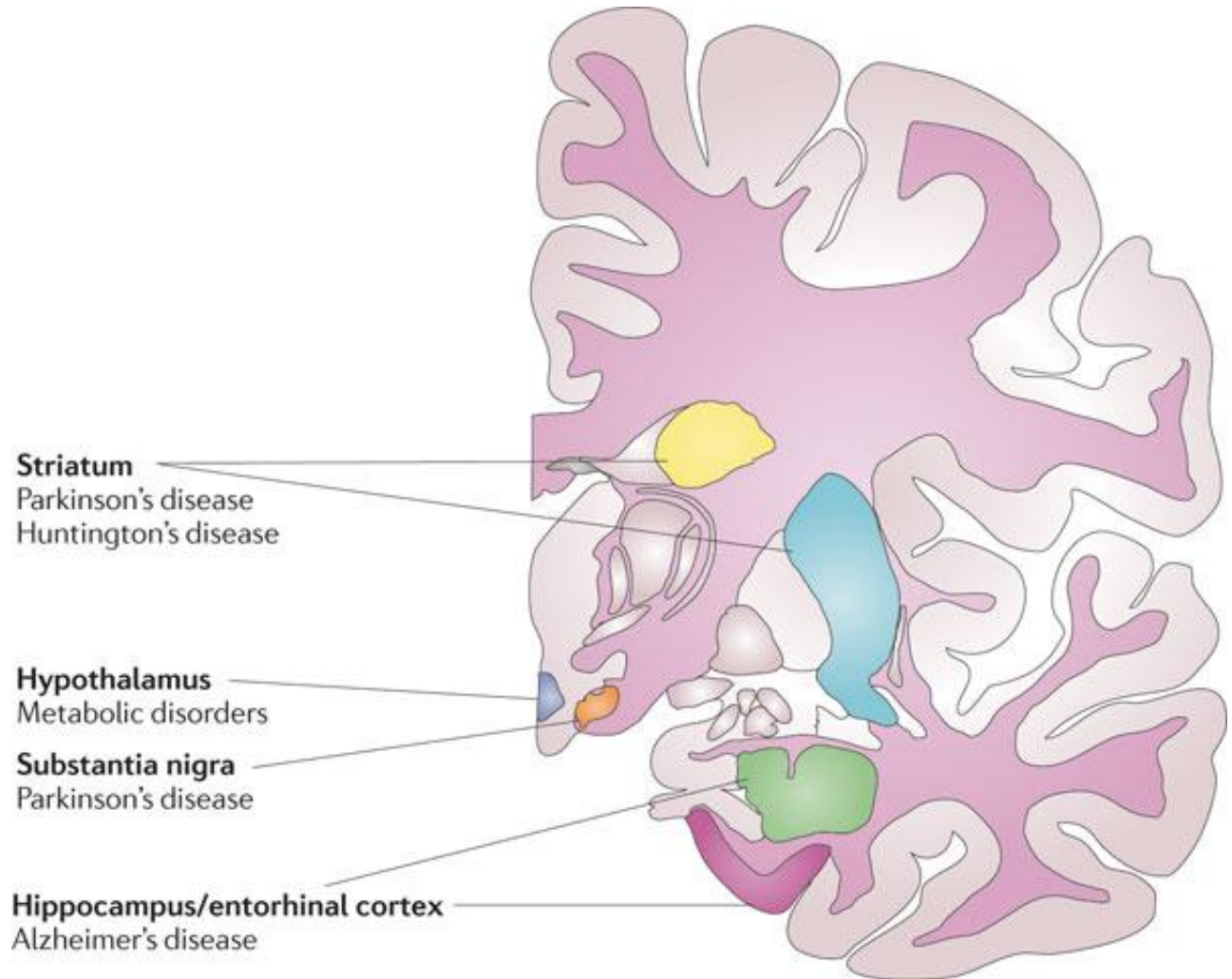
- Shown to immediately improve cognition
 - ▣ Study on mice and rats
 - Piepmeier & Etnier
- Long term
 - ▣ Voluntary exercise increase axon regeneration from neurons
 - Molteni et. al.
- Both showed positive difference between active and non-active animals
 - Few example of human testing



Illness in the Brain and BDNF

These are the areas of the brain that experience neurodegenerative disease

Research on how to target these areas with BDNF



Works Cited

- Anderson, B., McCloskey, D., Mitchell, N., & Tata, D. (2009). Exercise Effects on Learning and Neural Systems. (W. Chodzko-Zajko, A. Kramer, & L. Poon, Eds.) *Enhancing Cognitive Function and Brain Plasticity*, pp. 61-90.
- Bartholomew, J. B., & Ciccolo, J. T. (2007). Exercise, Depression and Cognition. (W. W. Spirduso, L. W. Poon, & W. Chodzko-Zajko, Eds.) *Exercise and its Mediating Effect on Cognition*, 2, pp. 33-46.
- Binder, D., & Scharfman, H. (2004, September 22). Brain-derived Neurotrophic Factor. *US National Library of Medicine*, pp. 123-131. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2504526/>
- Chodzko-Zajki, W., Kramer, A., & Poon, L. (2009). *Enhancing Cognitive Function and Brain Plasticity*. Champaign IL: Human Kinetics .
- Dietrich, A. (2003, April 1). Functional neuroanatomy of altered states of consciousness: The transient hypofrontality hypotheses. (S. Dirrect, Ed.) *Consciousness and Cognition*(12), 231-256.
- Dietrich, A. (2009). The transient hypofrontality theory and its implications for emotion and cognition. (T. McMorris, P. Tomporowski, & M. Audiffren, Eds.) *Exercise and Cognitive Function*, p. 69=90.
- Hathaway, W. (2007). Exercise and the Brain: Study links physical activity to greater mental acuity. *Hartford Courant*, 2.
- Molteni, R., Zheng, J.-Q., Ying, Z., & Gomez-Pinilla, F. (2004, March 1). Voluntary Exercise increases axonal regeneration from sensory neurons. *Neuroscience*, 101, pp. 8473-8478.
- Piepmeier, A., & Etnier, J. (2014). Brain-dervied neurotrophic factor(BDNF). *Journal of Sport and Health Sciences*. Retrieved from <http://dx.doi.org/10.1016/j.jshs.2014.11.001>
- Seifert, Thomas et. al. (2009). Endurance training enhances BDNF release from the Human Brain. *American Physiological Society Journal*, 372-377.
- Spirduso, W. W., Poon, L., & Chodzko-Zajko, W. (Eds.). (2009). *Exercise and its Mediating Effect on Cognition*.
- Toth., M. (n.d.). Neurotransmitters, genetic models and anxiety. *Monoamines and anxiety disorders*, pp. S151-S152.
- U.S. Library of National Medicine . (2015, April). *BDNF*. Retrieved from Genetic Home Reference: <http://ghr.nlm.nih.gov/gene/BDNF>
- Zunszain, P. A., Anacker, C., Cattaneo, A., Carvalho, L., & Pariante, C. M. (2011). The Neuro-inflammatory and Neuroprogressive PAtHways in Depression. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 35(3), 722-729.

Questions?

