Nature Versus Nurture

Neurons, The Brain and Nervous System

Science 2 Fall 2014

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Today’s Topics

- The Concept of Nature Versus Nurture
- Overview of Function of the Nervous System
- Anatomy of a Neuron
- Stages of the development of the brain
- Developmental Milestones
What is Nature Versus Nurture?

- What determines our physical characteristics?
  - Heredity?
    - Nature
  - Environment?
    - Nurture
Nature, Nurture or possibly both?

<table>
<thead>
<tr>
<th><strong>Nature (genetic)</strong></th>
<th><strong>Nurture (environment)</strong></th>
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<tbody>
<tr>
<td>Eye color (Blue, Brown, etc..)</td>
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<tr>
<td>Menopause</td>
<td>Hormone replacement therapy</td>
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<td>Production of Vitamins D</td>
<td>Vitamin D pills</td>
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<td>Allergies</td>
<td>Allergies</td>
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<tr>
<td>Disease (Diabetes, heart disease, cancer)</td>
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<td>We as a species have lost much of our body hair</td>
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<td>Pigmentation or skin color</td>
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Function of the Nervous System

- Helps Maintain Homeostasis - regulates its internal environment to maintain a stable, constant condition
  - Responds to internal environment
  - Responds to external environment

- Survival of the Organism
How Do Nerve Cells Communicate to Each Other?

- Chemically
- Electricity
Nature and Nurture in the Nervous System

- The neuron and its synapses are important in nature and nurture

1. http://chemistry.caltech.edu/~fucose/Neural%20Connections.htm
What is a Neuron?

- A neuron is an electrically excitable cell that processes and transmits information by electrical and chemical signaling.

- Chemical signaling occurs via synapses, which are specialized connections with other cells.

- Neurons connect to each other to form networks.

- Neurons are the core components of the nervous system which includes the brain, spinal cord, and peripheral ganglia.

Anatomy of the Neuron

- Dendrites
  - Receive Information
- Cell Body
  - Contains Nucleus and Genetic Information
- Axon
  - Transmits information
Anatomy of the Neuron

- **Synapse**
  - Site of communication between neurons
  - Site of neurotransmitter (NTX) release
    (chemicals which transmit signals from neuron to neuron or another cell)

- **Pre-synaptic Terminal**
  - Contains synaptic vesicles (with NTX)
Chemical synapses are: specialized junctions through which neurons signal to each other

- allow neurons to form circuits within the central nervous system,
- crucial to the biological computations that underlie perception and thought
- allow the nervous system to connect to and control other systems of the body

Anatomy of the Neuron

- Post-synaptic Neuron
  - Contains receptors for NTX
    - Neurotransmitters are chemicals which transmit signals from a neuron to a target cell across a synapse.
Anatomy of the Neuron

- Myelin - a dielectric (electrically insulating) material that forms a layer around the axon of a neuron. It is essential for the proper functioning of the nervous system.
  - Speeds conduction of action potentials (Nerve Impulses)

- Pre-synaptic Terminal
  - Contains synaptic vesicles (with NTX)
Nature and Nurture in the Nervous System

- What are the developmental milestones in the nervous system?
Fetal Development

- **First trimester**
  - Synapses begin to form

- **Second trimester**
  - The fetus can move

- **Third trimester**
  - Sensory pathways form
Newborn to 3 Months

- Visual and other systems start to mature
First Two Years

- 100 billion nerve cells form
- Myelination begins
First Two Years

- The following systems begin to develop
  - Motor
  - Language
  - Emotional
  - Memory
  - Sense of self
Two to Twelve Years

- Synapses are sculpted or strengthened by experience
Teen Years

- Last big maturation of the brain—a second growth and sculpting spurt—impacted in part by the activities one engages in (use it or lose it)
- Brain still developing (mainly the prefrontal cortex)
- Reasoning, Planning and Judgment abilities still not fully realized
- Emotional systems still maturing
- Attention systems still maturing
- Myelination continues
Diseases which manifest during the teen years – 20s

- Schizophrenia
- Depression
- Addiction
Early Twenties

- Memory systems start to decline
- Prefrontal cortex continues to mature
- New synapses in language and perception centers
- Myelination continues
Up to Thirty-two Years

- Myelination continues
The Aging Brain

- Small loss of cells
- Some loss of synapses
- Physical activity positively impacts the ability of the brain to remember information
- Evidence suggests that if an aging person remains active; doing so will decrease the rate of mental decline and possibly prevent it altogether
- Plasticity present through life
Diseases of the Aging Brain

- Parkinson’s disease
- Alzheimer’s disease
- Both can be treated at this point but neither cured with current technology
Topics Covered Today

- The Concept of Nature versus Nurture
- Nature and Nurture in the Nervous System
- Developmental Milestones of the Brain