Atypical Visual Development in Infants at Risk for Autism Spectrum Disorders (ASD)

Karen Dobkins

Organization and Development of the Nervous System: Osher Series

Karen Dobkins
Psychology Department
University of California, San Diego
5 Week Lecture Outline

1) Introduction and Neural Communication

2) Neurotransmitters and Drugs

3) Anatomy of the Nervous System

4) The Somatosensory System: Touch and Pain

5) Brain Development and Evolution
Lecture 1:
Introduction and Neural Communication
Osher Series

Karen Dobkins
Psychology Department
University of California, San Diego
Today’s Lecture Outline

1) Central vs. Peripheral Nervous System (CNS vs. PNS)

2) Spinal Cord

3) Mitosis and Regeneration in Neurons

4) Parts of a Neuron

5) Neural Communication
THE NERVOUS SYSTEM

1) **Central** Nervous System (CNS): Brain and Spinal Cord

2) **Peripheral** Nervous System (PNS): The Rest

Two types of cells in the Nervous System:

1) **Neurons** (100 billion, $10^{11}$):
   - communicate through electrical signals

2) **Glia** ($10^{12}$, but 1/10th the size of neurons)
   - form the myelin sheath (insulation) of neurons
Communication between brain (CNS) and senses and muscles (PNS) *below the head*.

**Spinal Column** = Spinal Cord + Backbone (i.e., vertebrae)

4 sections: *cervical* (8), *thoracic* (12), *lumbar* (5), *sacral* (5), and *coccyx*

C3, C4, C5: diaphragm movement (both voluntary and automatic control)

Christopher Reeve -> C 1-2
NEURON: Mitosis (Make New Cells/Neurons) and Regeneration (Repair Injured Neurons)

MITOSIS: After development, neurons in both the CNS and PNS lose their ability to undergo mitosis…… which is a bummer if there is an injury (e.g., stroke).

Why? they have a history of intricate connections

Exceptions: Some neurons that DO undergo Mitosis (adults)

1) Olfactory neurons
2) Isolated parts of bird, rodent and PRIMATE brain (e.g., hippocampus involved in memory)

QUESTION: As we age… don’t brain cells die and are not replaced? (uh-oh!)

No, they just shrink and are less functional. Phew! ??!
And what about BRAIN CANCER?

*Isn’t cancer when mitosis has gone wild??!!*

Well… brain cancer is usually GLIA, not NEURONS

Glial cells in both the CNS and PNS undergo mitosis.
REGENERATION:

of cut AXONS in the PNS …. not the CNS

In PNS, there are mechanisms for creating collagen around the injury to act as a “bridge” for axons to grow along.

Why not in CNS???
(especially important to know for spinal cord injury)

No one really knows why
How Neurons are like other cells:

- Nucleus (membrane-enclosed region containing DNA; hereditary control)
- Plasmalemma (control of material exchanges, mediation of cell-environment interactions)
- Endoplasmic reticulum (isolation, modification, transport of proteins and other substances)
- Mitochondrion (aerobic energy metabolism)
Components *unique* to NEURONS:
soma (sometimes called “cell body”)
dendrites (one or many): *receive signals*
axon (one main): *sends signals* (starts at axon hillock)
myelin sheath (glia): Not found in invertebrates
nodes of Ranvier (will come back to later today)
presynaptic (“before the synapse”) terminals
synapse
Neuronal Communication

Electrical signal sent from one neuron to the next
(from the “presynaptic” -> “postsynaptic” neuron, or muscle)

Neuromuscular Junction
Overview of Events:
1) Electrical signal starts in the presynaptic neuron and travels down the axon to the presynaptic terminals.
2) Causes release of neurotransmitter into the synapse
3) Neurotransmitter binds to receptors ($R$) on postsynaptic neuron’s dendrites
4) Triggers an electrical signal in postsynaptic neuron, and so on…..
Speed of Transmission:

speed of light: $3 \times 10^8$ m/sec
myelinated: 100 m/sec
thick unmyelinated: 10 m/sec
thin unmyelinated: 1 m/sec

🍎 DEMO of the “Nerve Impulse”
Electrical Signals Travel Along the Neuron with the ACTION POTENTIAL

ION CHANNELS in Membrane

$K^+ = \text{Potassium}$
$Na^+ = \text{Sodium}$

Open and Close, letting ions in/out of the neuron
Nodes of Ranvier / Saltatory Conduction

What goes wrong in Multiple Sclerosis?