# NEUROPLASTICITY

## The human brain and change

IB DP Psychology 2011/BLOA

# 4 Facts About Neuroplasticity

- ***1. Neuroplasticity includes several different processes that take place throughout a lifetime.*** Many types of brain cells are involved in neuroplasticity, including neurons, glia, and vascular cells.

- 2. ***Neuroplasticity has a clear age-dependent determinant.*** Your brain changes at all ages, but different kinds of changes are relevant at different ages.

# 4 Facts About Neuroplasticity

- **FACT 3: *Neuroplasticity occurs in the brain under two primary conditions:***
- 1. During normal brain development when the immature brain first begins to process sensory information through adulthood (developmental plasticity and plasticity of learning and memory).

- 2. As an adaptive mechanism to compensate for lost function and/or to maximize remaining functions in the event of brain injury.

# 4 Facts About Neuroplasticity

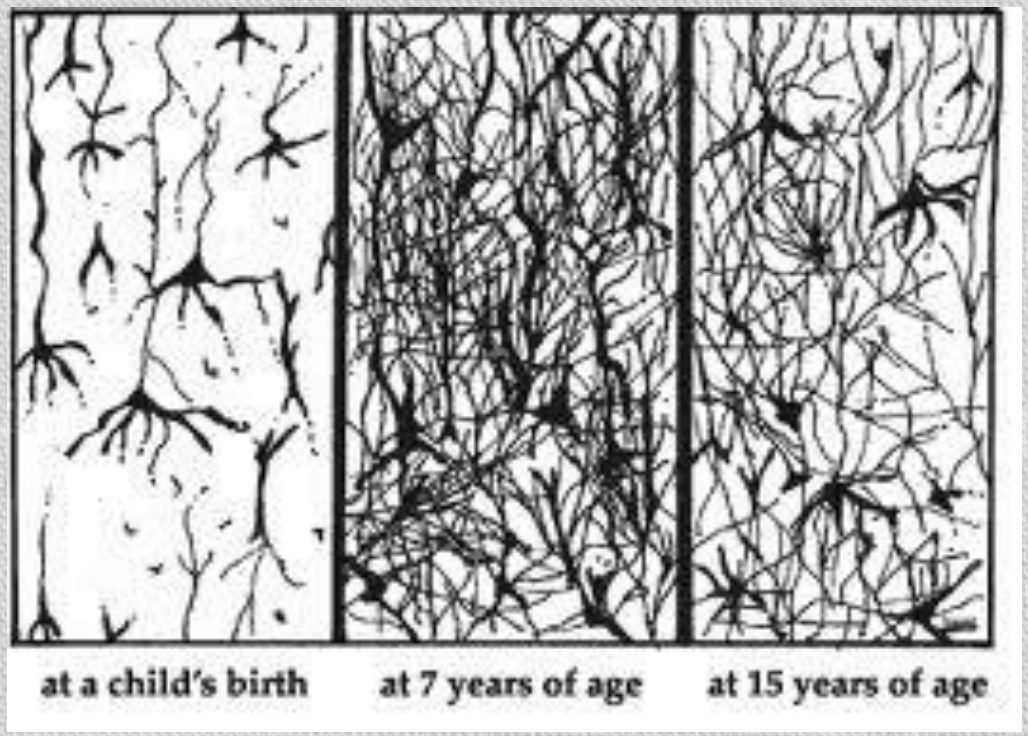
- **FACT 4:** ***The environment plays a key role in influencing plasticity.***
- In addition to genetic factors, the brain is shaped by the characteristics of a person's environment and by the actions of that same person.

# Developmental Plasticity: Synaptic Pruning

- Gopnick et al. (1999) describe neurons as growing telephone wires that communicate with one another.
- This process is called dendritic branching.
- Following birth, the brain of a newborn is flooded with information from the baby's sense organs.
- We are born with a fixed number of neurons – the brain's growth is caused by these neurons forming more connections
- At birth, each neuron in the cerebral cortex has approximately 2,500 synapses. By the time an infant is two or three years old, the number of synapses is approximately 15,000 synapses per neuron (Gopnick, et al., 1999).

# Synaptic Pruning

- The average adult neuron has about 8000  synaptic connections.
- Yes, as adults we have fewer connections
- As we age, old connections are deleted through a process called *synaptic pruning*.



# Why must synapses be pruned?

- Synaptic pruning eliminates weaker synaptic contacts while stronger connections are kept and strengthened.
- Experience/learning determines which connections will be strengthened and which will be pruned.
- Connections that have been activated most frequently are preserved.
- Neurons must have a purpose to survive. Without a purpose, neurons die through a process called apoptosis (pronounced ‘apotosis’)
- It is plasticity that enables the brain to adapt itself to its environment.

# Learning *is* plasticity!

- The capacity of the brain to change with learning is plasticity.

- According to Durbach (2000), there appear to be at least two types of modifications that occur in the brain with learning:

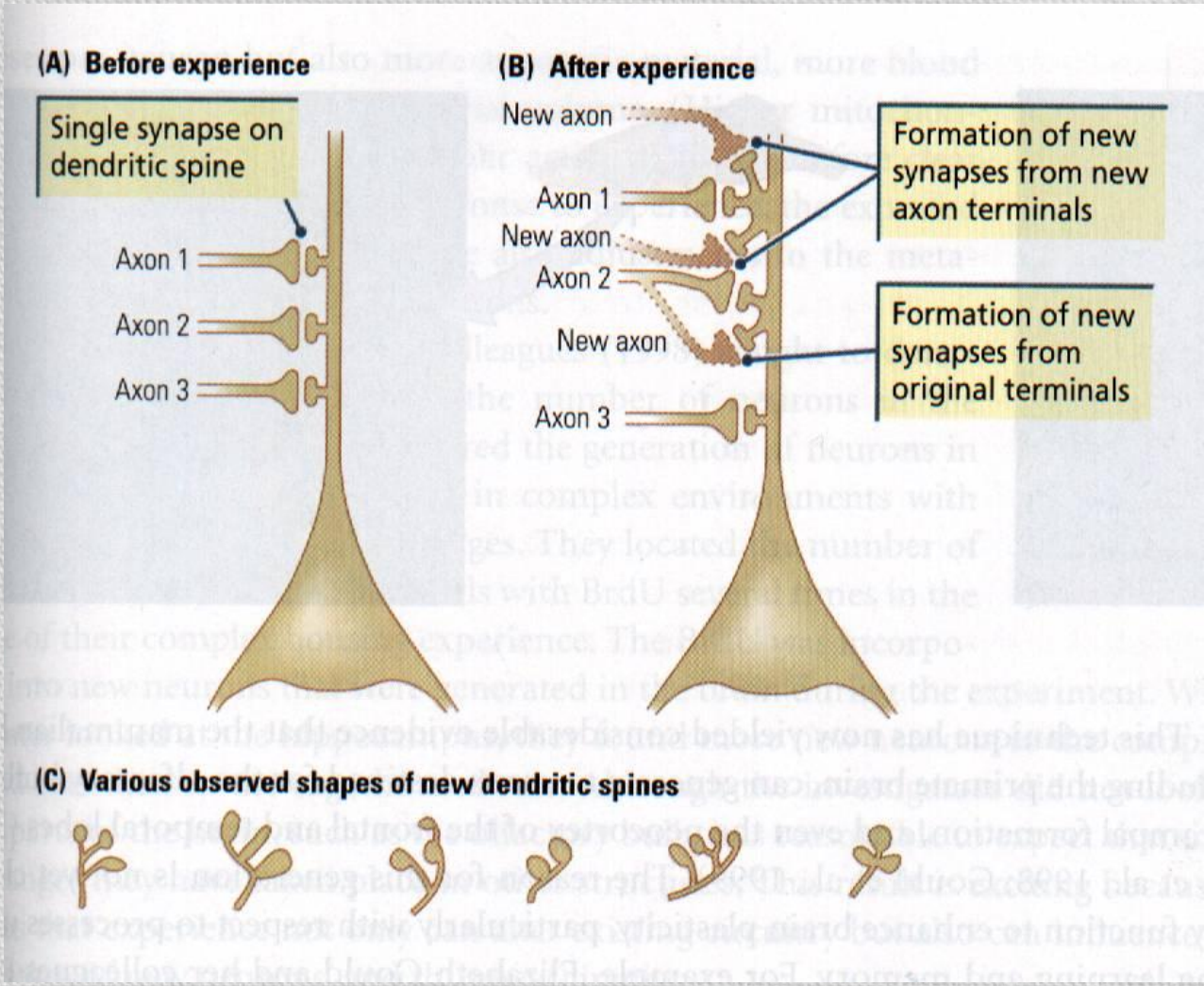
1) A change in the internal structure of the neurons, the most notable being in the area of synapses.
2) An increase in the number of synapses between neurons.

# What about Jodie who had a right hemispherectomy?

- **Injury-induced Plasticity/Plasticity and Brain Repair**

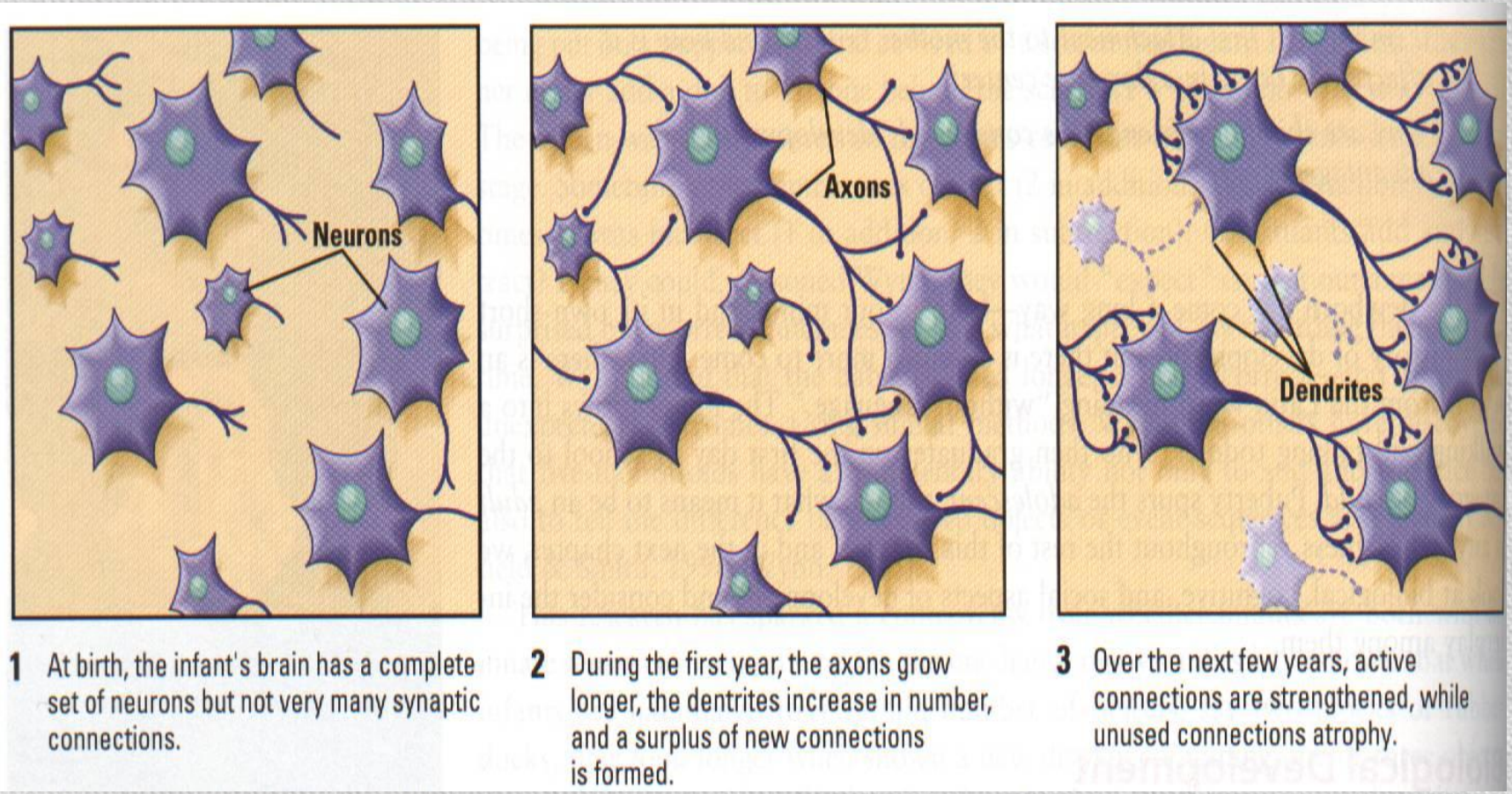
- During brain repair following injury, plastic changes maximize function in spite of the damaged brain.
- In studies involving rats in which one area of the brain was damaged, brain cells surrounding the damaged area underwent changes in their function and shape that allowed them to take on the functions of the damaged cells.
- Similar (thought not quite as effective) changes occur in human brains following injury.
- Jodie is a child, which helps her case, but even in adults, the brain has an amazing ability to repair itself

# Some illustrations of plasticity



# Some illustrations

## Synaptic apoptosis



# Lesson Plan

*Lesson on Neuroplasticity IB Psychology* *Mette Morell 2012*

**Learning Outcome: The effect of deprivation and stimulation on neuroplasticity**

**Key term definition** *Neuroplasticity:* The changing of neurons, the organization of their networks, and their function via new experiences.

- **PLAN**

| | |
|---|---|
| **1: What is neuroplasticity?**<br><br>**Example of patient case for illustration/discussion** | **We will begin by watching this clip together**<br>http://www.youtube.com/watch?v=rDTiZpPyqRk<br><br>**PPT by Mette Morell** |
| **2: Qs and As on the ppt** | **Students ask questions** |
| **3: The Rosenzweig and Bennett (1972)** | **The findings of the study are revised, and its generalizability and implication is discussed.**<br><br>**Central Questions**<br>- Do you know other examples of patients whose brains have been damaged?<br>- Is the brain always plastic?<br>- What does this study tell us about plasticity?<br>- To what degree can the findings of this study be generalized?<br>- What is the implication of the findings?<br>- What other studies on plasticity can you think of that involve humans? |

**Classic Study Used to Demonstrate Neuroplasticity: Rosenzweig & Bennett (1972)**

- Aim: To investigate the effect of enrichment or deprivation on the development of neurons in the cerebral cortex in rats
- Research method: Laboratory Experiment
- Procedure: Rats were placed in either a stimulating environment (*toys*) or a deprived environment (*no toys*). The rats spent 30 or 60 days in their environment and then they were dissected.
- Findings: Post mortem studies of the rats' brains showed that those that had been in a stimulating environment had an increased thickness in the cortex.

**New studies demonstrating brain plasticity – some also in humans:**
Kolb (1999)
Goldapple (2004)
Small and Vorgan (2008)