Neuroplasticity
Part I

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Presentation Objectives

- Define the concept of Neuroplasticity
- Review the history
- Compare and contrast functional vs conventional neurology
- Discuss the neurological mechanisms
- Outline the physiologic benefits of neuroplasticity


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PERCEPTION
EMOTIONS
MOTOR CONTROL
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AMNESIA
RECEPTORS
PSYCHOLOGY
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NEUROTRANSMITTERS
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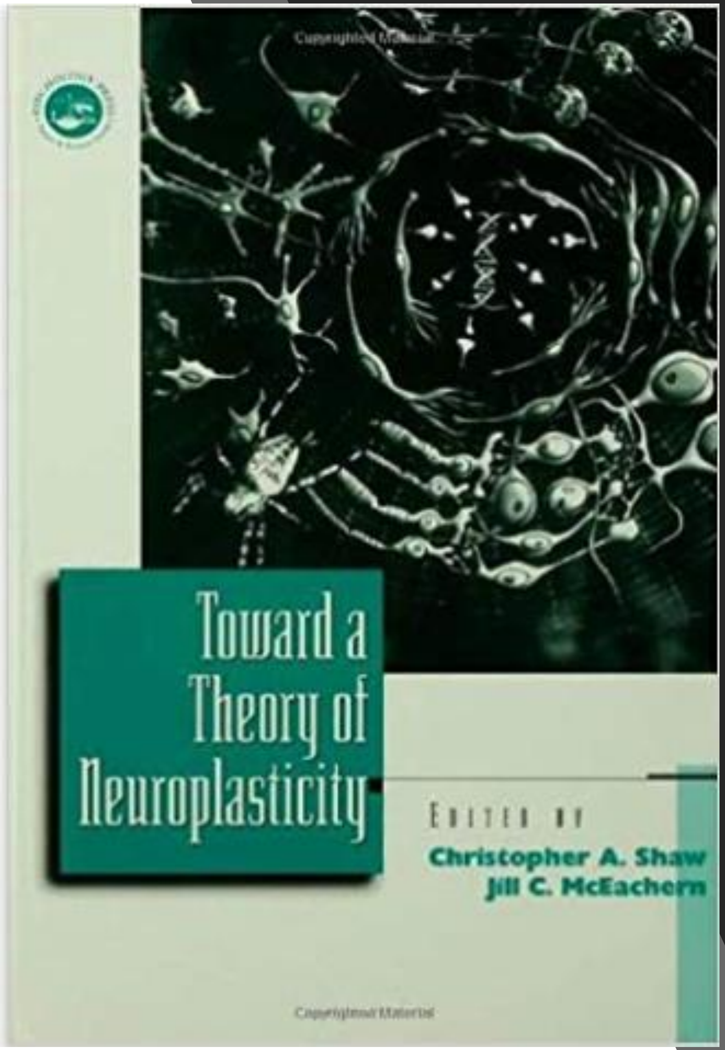
INTELLECT
CONCENTRATION
ANATOMY
NEUROSURGERY
ANALYSIS
MEMORIES
REFLEX
ORGAN
INNOVATION
CONCEPT
HOSPITAL
NERVOUS SYSTEM
CEREBELLUM



Classification of Neuroplasticity

“While many neuroscientists use the word neuroplasticity as an umbrella term, it means different things to researchers in different subfields… In brief, a mutually agreed upon framework does not appear to exist” (2001)

- Christopher A. Shaw and Jill C. McEachern

Two main perspectives on neuroplasticity:

- Neuroplasticity is one fundamental process that describes any change in final neural activity or behavioral response.
- Neuroplasticity is an umbrella term for a vast collection of different brain change and adaptation phenomena.

Common Definition of Neuroplasticity

- Neuroplasticity refers to the brain’s ability to change and adapt that occur as the result of our interactions with our environment.
- From the time the brain begins to develop in utero until the day we die, the connections among the cells in our brains reorganize in response to our changing needs.
- This dynamic process allows us to learn from and adapt to different experiences.

A Brief History of Neuroplasticity

- The term “neuroplasticity” was first used by Polish neuroscientist Jerzy Konorski in 1948 to describe observed changes in neuronal structure (neurons are the cells that make up our brains)—although it wasn’t widely used until the 1960s—but the idea goes back even farther (Demarin, Morović, & Béne, 2014). The “father of neuroscience,” Santiago Ramón y Cajal, talked about “neuronal plasticity” in the early 1900s (Fuchs & Flügge, 2014). He recognized that, in contrast to current belief at that time, brains could indeed change after a person had reached adulthood.
- In the 1960s, it was discovered that neurons could “reorganize” after a traumatic event. Further research found that stress can change not only the functions but also the structure of the brain itself (Fuchs & Flügge, 2014).
- In the late 1990s, researchers found that stress can actually kill brain cells—although these conclusions are still not completely certain.
- For many decades, it was thought that the brain was a “nonrenewable organ,” that brain cells are bestowed in a finite amount and they slowly die as we age, whether we attempt to keep them around or not. As Ramón y Cajal said, “In adult centers the nerve paths are something fixed, ended, immutable. Everything may die, nothing may be regenerated” (as cited in Fuchs & Flügge, 2014).
- This research found that there are other ways for brain cells to die, other ways for them to adapt and reconnect, and perhaps even ways for them to regrow or replenish. This is what’s known as “neurogenesis.”

Conventional Neurology vs. Functional Neurology

- The human brain, which consists of approximately 100 billion neural cells, could not generate new ones.
- You were born with a finite number of brain cells, and when a cell died, no new cell grew in its place.
- The human brain had a relatively small window to develop new pathways in our life span, then after that the pathways became immutable.
- Our ability to generate new pathways dropped off sharply around the age of 20, and then became permanently fixed around the age of 40.

Conventional Neurology vs. Functional Neurology

- New studies have shown through the use PET, and MRI brain scanning technology, that new neural cells are generated throughout life as well as new neural pathways
- Enriched environments (saturated with novelty, focused attention, and challenge) are critical for promoting neuroplasticity, and can provoke growth and positive adaptation long after the “critical learning period” of early childhood and young adulthood is over (Kempermann et al., 2002; Vemuri et al., 2014).
- “Newborn” neurons at 8 weeks old and older neurons are generally at the same level of maturation (Deshpande et al., 2013).
- As few as ten ~ 1-hour sessions of cognitive training over 5 or 6 weeks have the potential to reverse the same amount of age-related decline that has been observed in the same time period (Ball et al., 2002).
- Physical activity can prevent or slow the normal age-related neuronal death and damage to the hippocampus, and even increase the volume of the hippocampus (Niemann et al., 2014).
- Intermittent fasting can promote adaptive responses in synapses (Vasconcelos et al., 2014).
- Chronic insomnia is associated with atrophy (neuronal death and damage) in the hippocampus, while adequate sleep may enhance neurogenesis (Joo et al., 2014).

How does Neuroplasticity work?

Types of Brain Plasticity

Functional plasticity - Brain's ability to move functions from a damaged area to undamaged area

Structural plasticity – Brain’s ability to actually change its physical structure as a result of learning

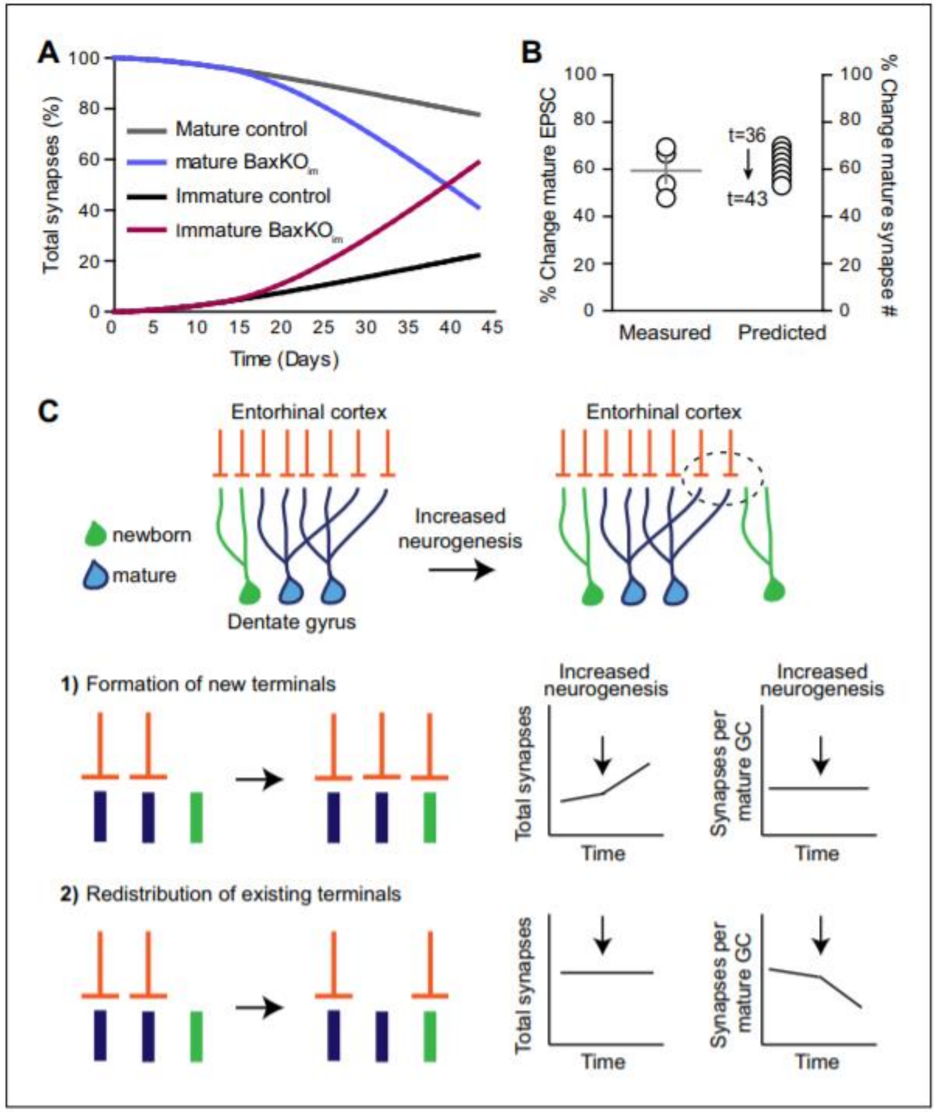
Neuroplasticity vs. Neurogenesis

Neuroplasticity is the ability of the brain to form new connections and pathways and change how its circuits are wired

Neurogenesis is the even more amazing ability of the brain to grow new neurons.

Neurogenesis

- Neurogenesis is the process by which new neurons are formed in the brain. Neurogenesis is crucial when an embryo is developing, but also continues in certain brain regions after birth and throughout our lifespan.



Research and Studies on Neuroplasticity

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- As few as ten ~ 1-hour sessions of cognitive training over 5 or 6 weeks have the potential to reverse the same amount of age-related decline that has been observed in the same time period (Ball et al., 2002).
- Physical activity and good physical fitness can prevent or slow the normal age-related neuronal death and damage to the hippocampus, and even increase the volume of the hippocampus (Niemann et al., 2014).
- Intermittent fasting can promote adaptive responses in synapses (Vasconcelos et al., 2014).
- Chronic insomnia is associated with atrophy (neuronal death and damage) in the hippocampus, while adequate sleep may enhance neurogenesis (Joo et al., 2014).

Benefits of Neuroplasticity on the Brain

Recovery from brain events like strokes.

Recovery from traumatic brain injuries.

Ability to rewire functions in the brain (e.g., if an area that controls one sense is damaged, other areas may be able to pick up the slack).

Losing function in one area may enhance functions in other areas (e.g., if one sense is lost, the others may become heightened).

Enhanced memory abilities.

Wide range of enhanced cognitive abilities.

More effective learning.

Recommended Readings on Neuroplasticity

- **The Brain's Way of Healing**: Remarkable Discoveries and Recoveries from the Frontiers of Neuroplasticity by Norman Doidge
- **Neuroplasticity** (MIT Press Essential Knowledge Series) by Moheb Costandi
- **Switch on Your Brain:** The Key to Peak Happiness, Thinking, and Health by Dr. Caroline Leaf
- **The Power of Neuroplasticity** by Shad Helmstetter
- **The Stress-Proof Brain:** Master Your Emotional Response to Stress Using Mindfulness & Neuroplasticity by Melanie Greenberg
- **The Brain That Changes Itself:** Stories of Personal Triumph from the Frontiers of Brain Science by Norman Doidge
- **The Mind and the Brain:** Neuroplasticity and the Power of Mental Force by Jeffrey M. Schwartz and Sharon Begley