

SLHS1402 The Talking Brain



Neuroscience Core Concepts

THE ESSENTIAL PRINCIPLES OF NEUROSCIENCE



What are neuroscience core concepts?



- Neuroscience Core Concepts offer fundamental principles that one should know about the brain and nervous system, the most complex living structure known in the universe. They are a practical resource about:
 - How your brain works and how it is formed.
 - How it guides you through the changes in life.
 - Why it is important to increase understanding of the brain.

Central Nervous System



- **The Nervous System Controls and Responds to Body Functions and Directs Behavior**
 1. **The brain is the body's most complex organ.**
 - There are a hundred billion neurons in the human brain, all of which are in use. Each neuron communicates with many other neurons to form circuits and share information. Proper nervous system function involves coordinated action of neurons in many brain regions. The nervous system influences and is influenced by all other body systems (e.g., cardiovascular, endocrine, gastrointestinal and immune systems). Humans have a complex nervous system that evolved from a simpler one. This complex organ can malfunction in many ways, leading to disorders that have an enormous social and economic impact.

Electrically wired, chemically mediated



- **2. Neurons communicate using both electrical and chemical signals.**
- Sensory stimuli are converted into electrical signals. Action potentials are electrical signals carried along neurons. Synapses are chemical or electrical junctions that allow electrical signals to pass from neurons to other cells. Electrical signals in muscles cause contraction and movement. Changes in the amount of activity at a synapse can enhance or reduce its function. Communication between neurons is strengthened or weakened by an individual's activities, such as exercise, stress, and drug use.
- All perceptions, thoughts, and behaviors result from combinations of signals among neurons.

Neurons and Neurotransmitters



An artistic rendering of emerging technologies in action. Blue and yellow lights can be used to evoke or inhibit electrical activity in neurons (represented by the intense glow).

Genes + Environment



- **Nervous System Structure and Function Are Determined by Both Genes and Environment Throughout Life**
- **3. Genetically determined circuits are the foundation of the nervous system.**
- Neuronal circuits are formed by genetic programs during embryonic development and modified through interactions with the internal and external environment. *Sensory* circuits (sight, touch, hearing, smell, taste) bring information to the nervous system, whereas *motor* circuits send information to muscles and glands. The simplest circuit is a reflex, in which a sensory stimulus directly triggers an immediate motor response. Complex responses occur when the brain integrates information from many brain circuits to generate a response. Simple and complex interactions among neurons take place on time scales ranging from milliseconds to months. The brain is organized to recognize sensations, initiate behaviors, and store and access memories that can last a lifetime.

Nature and Nurture



Who we are is the product of our genes or blueprint, contained in every one of our cells (at top), and our environment, much of which comes from the rich contributions of our family and culture

Plasticity: Changes in the Brain



- **4. Life experiences change the nervous system.**
- Differences in genes and environments make the brain of each animal unique. Most neurons are generated early in development and survive for life. Some injuries harm nerve cells, but the brain often recovers from stress, damage, or disease. Continuously challenging the brain with physical and mental activity helps maintain its structure and function — “use it or lose it.” Peripheral neurons have greater ability to regrow after injury than neurons in the brain and spinal cord.
- Neuronal death is a natural part of development and aging. Some neurons continue to be generated throughout life and their production is regulated by hormones and experience.

Life-changing experience



Control of balance and coordinated movement arises at a specific stage of development and requires practice with a tutor.

Life-changing experience



- A dancer with the Mark Morris Dance Group leads a weekly dance class for people with Parkinson's disease allowing them to experience dance and movement.

Brain produces mind.



- **The Brain Is the Foundation of the Mind**
- 5. The brain makes sense of the world by using all available information, including senses, emotions, instincts and remembered experiences. Emotions are based on value judgments made by our brains and are manifested by feelings as basic as love and anger and as complex as empathy and hate. The brain learns from experiences and makes predictions about best actions in response to present and future challenges. Consciousness depends on normal activity of the brain.



- A student ponders the marvels of a model of the skull that contains the human brain. The top has been cut away to reveal the cranial nerves that leave the skull at its base.

Language at the crown of human intelligence



- **6. The brain makes it possible to communicate knowledge through language.**
- Languages are acquired early in development and facilitate information exchange and creative thought.

Communication can create and solve many of the most pressing problems humankind faces.

Disorders and Treatments



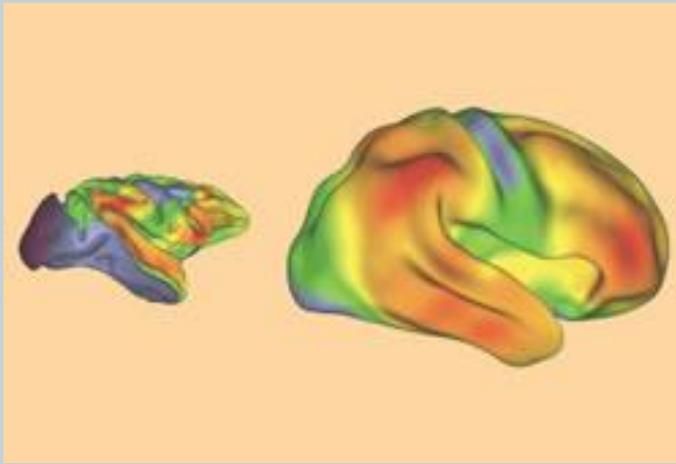
- **Research Leads To Understanding that Is Essential for Development of Therapies for Nervous System Disorders**
- **7. The human brain endows us with a natural curiosity to understand how the world works.**
- The nervous system can be studied at many levels, from complex behaviors such as speech or learning, to the interactions among individual molecules. Research can ultimately inform us about mind, intelligence, imagination, and consciousness. Curiosity leads us to unexpected and surprising discoveries that can benefit humanity.

Significance of Basic Research



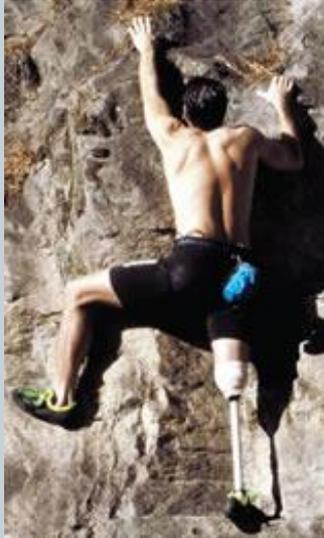
- **8. Fundamental discoveries promote healthy living and treatment of disease.**
- Experiments on animals play a central role in providing insights about the human brain and in helping to make healthy lifestyle choices, prevent diseases, and find cures for disorders. Research on humans is an essential final step before new treatments are introduced to prevent or cure disorders.
- Neuroscience research has formed the basis for significant progress in treating a large number of disorders. Finding cures for disorders of the nervous system is a social imperative.

Research findings



- A map of how the cerebral cortex has expanded in humans compared to the macaque monkey, displayed on side views of macaque (left panel) and human (right panel) cortical atlases. Red patches in the parietal, frontal, and temporal lobes indicate regions that are likely to have expanded most rapidly in humans compared to monkeys.

Academics and Beyond



(left) Advanced therapeutics allow a climber to scale a cliff with an artificial leg. The development of brain-prosthesis interfaces give injured patients new hope.



(right) Young researchers become involved in laboratory work that will lead to future treatments for neurological disorders.