PSY 375 Neuropsychology

- **CORE CONCEPTS**
- NEUROPSYCHOLOGY:

Investigates functions and the structure of the brain and relate those to the overt/covert psychological phenomenon. Try to understand "normal brain functioning" by studying injured or defected brain.

- WHAT IS THE BRAIN?

Brain is a multi-part structure

Create consciousness

Construct reality

Make up fantasies

Enable us to survive by running it's specifically evolved mechanisms to maintain our safety, rewards and socializing

- **FACTS ABOUT THE BRAIN**

- For human: One of the biggest mysteries in the universe.
- Humans have the most complex brain of any animal on earth.
- The right side of your brain controls the left side of your body, and the left side of your brain controls the right side of your body.
- Humans ***do not*** **use only 10%** or less of their brain
- Your brain uses 20% of your body's energy, Your brain uses 20% of your oxygen but it makes up only 2% of your body's weight.
- ...your brain consists of 60% white matter and 40% grey matter
- ...all of your "thinking" is done by electricity and some chemicals called neurotransmitters
- The brain has no pain. Because there are no nerves that register pain within the brain itself,

- An elephant's brain is about six times as large as a human brain. In relation to body size, however, humans have the largest brain of all the animals (about 2% of body weight)

- Your brain has about 100 billion neurons. A typical brain cell has from 1,000 to 10,000 connections to other brain cells. There are 1,000 to 10,000 synapses for a "typical" neuron.
- Our brain often fools us.
- Brain does not keep the memories as pictures painted in the cells. It is all electrical.

CLINICAL NEUROPSYCHOLOGY:

Try to establish rehabilitation strategies for neuropsychological pathologies.

NEUROPSYCHIATRY:

Try to understand normal functioning of the brain by investigating mental illnesses and their neural substrates.

- METHODS IN NEUROPSYCHOLOGY

Information Processing Approach:

In a limited system, information is coded selectively and in an organized fashion (Brain as hardware and the mind as software). Inputs gets in, get processed and an output get produced.

- Distributed processing
- İnformation get processed with the wide spread network all around the brain
-

Modularity (domain specific) V.S Domain General Processing (Distributed)

- Modular View: Specific modules (which are innate) only process specific input.
- Domain General View: processing is distributed and an area or module may respond to more than one stimulus or to similar stimuli.
- Ex: Face Processing (Fusiform Face Area)

- COGNITIVE MODELLING:boxes and arrows to explain a specific process.
- CONNECTIONIST MODELLING
- Effort of creating computer models of the cognitive functions. Central connectionist principle is that mental phenomena can be described by interconnected networks of simple units.
- NEURONAL NETWORKS
- traditionally used to refer to a network or circuit of biological neurons. Modern usage refers to mathematical or artificial models of biological neural systems.

- DEVELOPMENT OF THE CENTRAL NERVOUS SYSTEM
- AND
- NEURODEVELOPMENTAL DISORDERS
- After fertilization, egg divides in to number of cells and gives rise to three layer structure.
- On the outer layer, the neural tube forms which then turns in to the brain and the spinal court.

Brain development is a long and complicated process which involves:

- *Cell Proliferation* (Generation of new undifferentiated cells - neuroblasts)
- *Migration* (Neuroblasts migrate to where they belong)
- *Differentiation* (Neuroblasts change in to specific types of neurons)
- *Synaptogenesis* (Synapses emerge between differentiated neurons)
- *Selective cell dead* (Cells that do not get hooked to a friend, die off).
- Three swellings in the neural tube form the basis of the brain structure.
- Forebrain: Telencephalon, Diencephalon
- Midbrain: Mesencephalon
- Hindbrain: Metencephalon, Myelencephalon
- NERVOUS SYSTEM
- The nervous system informs the body about itself and the world around it. Enables body to react to this information.

Peripheral nervous system divided in two.

***Somatic N.S* :**is the sensory gateway between outside of the body and CNS. Sensory receptors provide connection between stimuli such as heat, cold, pain and CNS. Later via motor neurons, appropriate action will be taken and messages will be send to muscles.

***Autonomic* N.S:** is responsible for reflexive action. (Ex. Increasing or decreasing the heart rate.)

- **Central nervous system** process the information received from peripheral N.S. Interprets the signals and send them back.
- Structure of A Neuron

All the neurons have the same parts

But, they have different shapes depending on their jobs

- Incoming and outgoing signals are carried by NEURONS. A neuron is the most basic building block of the nervous system. They are electrically excitable cells which process and transmit information by electrical and chemical signaling. They are specialized cells in transmitting the information.
- INTERNEURON: Neurons lying entirely within the CNS (Composing the brain).
- AFFERENT NEURONS (Sensory Neurons): Carry signals from the sensory organs to the CNS.
- EFFERENT NEURONS (Motor Neurons): Carry signals from CNS to the cells in PNS.
- GLIA(Glue)

- Glias are smaller and more crowded then neurons
- Glias holds the neurons together and allow them to make their job.
- There are many types of Glias

- ASTROCYTES

Connects to the axons and they provide a synchrony of activations. Message can be send in waves.

Removes the death neurons

Controls the blood flow to the brain areas

- MICROGLIA

Act as the immune system of the brain

Removes the viruses and other microorganisms from the brain

- OLIGODENDROCYTES
- Produces the myelin for the axons
- One oly. Connects more than one axons.

- RADIAL GLIA

Guide the neuroblasts during the migration at the beginning of the brain development.

- THE BLOOD-BRAIN BARRIER
- BBB

THE BLOOD BRAIN BARRIER

1- Enables the brain to get what it wants from the blood

What happens if a cell is infected in the body?

What happens if a neuron is infected in the brain?

2- B.B.B protects the brain from the diseases and irreplaceable damage.

- How the BBB works
- HOW THE BLOOD BRAIN BARRIER WORKS

In the body, the capillary cells have small gaps between them. In the brain they do not. In the brain nothing passes between them and there is a special mechanism (an active transport system) to carry the substances through.

O_2, CO_2, water and the molecules which dissolves in the fat can cross the BBB

Other required chemicals such as Glucose and amino acids gets in via the active transport which requires energy

- COMMUNICATION AT SYNAPSES
- THE CONCEPT OF THE SYNAPSE
- WAYS OF NEURAL COMMUNICATION AND ACTIVATION
- TEMPORAL SUMMATION
- SPATIAL SUMMATION
- INHIBITORY SYNAPSES

Some synapses, instead of depolarizing the cell to the excitation threshold, they hyperpolarize the membrane to inhibit the activity.

Why?

When you contrast a specific muscle amongst many others, the neighboring muscles need to be inhibited to prevent them from getting involved to the intentional movement.

- WIRING DIAGRAM OF THE NERVOUS SYSTEM

- Wiring diagram
- Back to Sherrington

After the discovery of the difference of the transmission speed between neurons, he was quite famous at his time.

He was saying that the transmission between neurons is electrical, chemical reaction can not be fast enought.

Is he right or wrong?

Loewi was having restless nights

One night he woke up after a dream

and…

AND SYNAPSE!!!!

- The sequence of the chemical events at the synapse

1- neuron contains neurotransmitters at the terminal buttons. Neurotransmitters are the chemicals which stimulates the post-synaptic cell.

2- action potential travels down the axon and when it comes to the terminals it allows the calcium to enter the cell releasing the transmitters in to the synaptic cleft.

3- transmitters go and bind to the receptors of the P.S.N. altering its state.

4- transmitters break free from the receptors

5- some of the transmitters collected back by P.S.N, and some of them are destroyed by enzymes.

- TYPES OF NEUROTRANSMITTERS

Brain uses different kinds of neurotransmitters

How many N.Ts one neuron releases?

One neuron releases many kinds of transmitters.

Different neurons secrets different kinds of transmitters.

SECRETING DIFFERENT TRANSMITTERS ENABLES MESSAGE TO BE VERSATILE AND COMPLEX

<u>EXCITATORY</u>

Acetylcholine

Epinephrine

Norepinephrine

Glutamate

Dopamine

INHIBITORY

Gaba

Dopamine

- IONOTROPIC – METABOTROPIC EFFECTS

The effect of a neurotransmitter depends on the receptor which receives it.

Receptor may open a channel exerting an ionotropic effect

Or

May produce slower but longer –metabotropic- effect

These two effects contribute to different aspects of the behavior and sensation

- IONOTROPIC EFFECTS

Most ionotropic effects depends on either Glutamate or GABA

Ionotropic effects starts and stops very quickly

For vision and hearing, brain needs rapid and quickly changing information.

That's why that's kind of effect is well suited for conveying visual, auditory and other kind of information that needs to be up-dated as quickly as possible.

- METABOTROPIC EFFECTS

At some receptors, neurotransmitters initiates slower and longer-lasting effects

Metabotropic synapses are better suited for more enduring effects such as taste, smell, pain, arousal, attention, pleasure and emotion.

In this situations exact timing is not important!

Metabotropic effect rises slowly and last longer in comparison to visual or auditory stimuli.

- SYNAPSE

Dendrites collect the incoming information. Electrical charge travels along the axon. It gets translated in to the chemical language in the synaptic cleft. Neurotransmitters are released and some of them go bind to the post-synaptic receptor in the terminal button. However some of them do not.

Those which get bind, triggers an electrical activation in post.s.n. Those which did not, either get collected by pre.s.n for future use or get broken down by special enzymes. This way message gets transmitted to the next neuron.

SYNAPSE: The way neurons communicate in chemical terms and transmit information to each other.

- NEURODEVELOPMENTAL DISORDERS

AUTISM DISORDER

Disorder: Not a single symptom but a group of symptoms seen together.

Main symptoms:

Impairment in social interaction and communication.

Restricted interests and repetitive behaviors.

Decreased ability of empathy.

There is a strong genetic base and exact etiology is not known.

Some hypothesis:

Neuropsychological hypothesis: An excess of neurons that causes over-connectivity in some local regions but weak connections between association cortices, frontal cortex and the rest of the brain.

Mirror System Theory of Autism: Mirror neurons fire when we observe an action and also when we perform the same action. They provide facilitation for imitation and learning. They are located in pre-motor cortex and inferior parietal lobule. Distortions in development of M.N.s interferes with the imitation ability and leads to social and communicational difficulties.

- **AD/HD (Attention Deficit Hyperactivity Disorder)**
- Main symptoms:
- Hyperactivity: They can not seat steel. This start disturbing school achievement and social relationships.
- Inattention : They can not sustain their attention as long as their peers.
- Impulsivity : They do not think before they act.

3 subtypes

- Hyperactive-Impulsive type: Does not show significant inattention problem.
- Inattentive type: No significant hyperactive/impulsive symptoms.
- Combined type.
- **AD/HD (Attention Deficit Hyperactivity Disorder)**

To be diagnosed with ADHD, the individual needs to meet either the first set or the second set of criteria below.

The first set focuses on symptoms of **inattentiveness**. ADHD would be diagnosed in someone who has six or more of the following symptoms. The symptoms would need to have been there for at least six months. And they would need to be inconsistent with the person's developmental level. The symptoms include:

- Often failing to give close attention to details or often making careless mistakes in schoolwork, work, or other activities
- Often having difficulty sustaining attention in tasks or play activities
- Often seeming not to listen when spoken to
- Often not following through on instructions and failing to finish schoolwork, chores, or duties in the workplace
- Often finding it difficult to organize tasks and activities
- Often avoiding doing or disliking or being reluctant to engage in tasks that require sustained mental effort
- Often losing things that are necessary for tasks or activities (for example, toys, school assignments, pencils, books, or tools)
- Often being easily distracted by extraneous stimuli
- Often being forgetful in daily activities

The second set of criteria focuses on symptoms of hyperactivity-impulsivity.

- symptoms of hyperactivity include:
- Often fidgeting with hands or feet or squirming in seat
- Often leaving his or her seat in the classroom or in other situations where remaining seated is expected
- Often running about or climbing excessively in situations in which it is inappropriate (in adolescent or adults this may be limited to subjective feelings of restlessness)
- Often having difficulty playing or engaging in leisure activities quietly
- Often being "on the go" or acting as if being "driven by a motor"
- Often talking excessively
- Symptoms of impulsivity include:
- Often blurting out answers before questions have been completed

- Often having difficulty awaiting turns
- Often interrupting or intruding on others (for example, butting into conversations or games)

impaired cognitive functions in AD/HD

- ADHD individuals made more Perseverative errors on the WCST than did non-ADHD controls, suggesting that ADHD is associated with impaired cognitive flexibility.
- At present, there is compelling evidence suggesting that several key brain functions are implicated in ADHD—attention, executive functions, processing of temporal information, and responses to reinforcement (Nigg and Nikolas 2008)—all of which are critical for modulating behavior (Barkley 1997; Nigg and Casey 2005)
- **Data synthesis:** The meta-analyses indicate that vigilance (sustained attention), response inhibition, and working memory are impaired in children diagnosed with ADHD. Similar but somewhat less consistent meta-analytic findings have been reported for impairments in alertness, cognitive flexibility, and planning. Additionally, the literature suggests deficits in temporal information processing and altered responses to reinforcement in children diagnosed with ADHD.
- The construct suggests that neuropsychological evaluation will reveal that a subset of children with attention problems will exhibit a syndrome that includes difficulty in spatial processing, abstract concept formation, and nonverbal or visual reasoning. Informal observation or clinical interview may reveal poor social skills as well.

The following six clusters of executive functions tend to be impaired in individuals with ADD/ADHD:

- Activation: organizing tasks and materials, estimating time, getting started.
- Focus: focusing, sustaining focus, and shifting focus between tasks.
- Effort: regulating alertness, sustaining effort and processing speed.
- Emotion: managing frustration and modulating emotions.
- Memory: using working memory and accessing recall.
- Action: monitoring/ regulating actions.
- The most apparent cognitive problem—and in some views the cognitive hallmark of ADHD—is a weakness in executive functioning. Persons with ADHD may have difficulty in planning the steps involved, for example, in organizing a party or doing long division in the correct sequence. This may be a consequence of problems in working memory capacity, in handling interfering information, in integrating behavioral sequences, or in suppressing triggered responses in a fast decision-making context.
- those diagnosed with ADHD were consistently slower in stopping an ongoing response, suggesting difficulty in response inhibition.

- A Compendium of Neuropsychological ... - Google Kitap Arama
- a compendium of neuropsychological tests - Google Kitap Arama
- Assessment Links
- Brainmetric Software - The Category Test
- Buros Institute of Mental Measurements
- CATs Program Downloads
- Clinician's Guide to ... - Google Kitap Arama
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- eMedicine - Neuropsychological Evaluation Article by Atif Malik
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◉ NERVOUS SYSTEM AND NEUROANATOMY

◉

◉ NERVOUS SYSTEM

PERIPHERAL NERVOUS SYSTEM AND THE SPINAL COURT

PNS accomplishes two very important tasks.

1- collecting info. And controlling voluntary muscles

2- controlling the heart rate and the involuntary muscles

Somatic Nervous System enables organism to be aware of its environment by sending all the info. to the CNS. CNS understands and interpret the information. It is composed of the BRAIN and the SPINAL COURT

- THE AUTONOMIC NERVOUS SYSTEM

A.N.S receives the necessary information and sends the outputs for required adjustments to the involuntary muscles and the organs such as hearth.

It divided in two.

-sympathetic

-parasympathetic

- THE SPINAL CORD
- **THE MAJOR DIVISIONS OF THE BRAIN**
- **NEUROANATOMICAL TERMS AND STRUCTURES**

Each individual has a role in the society Similarly each neuron and each brain area Has a unique role, however effective Functioning depends on collaboration.

- MAJOR DIVISIONS OF THE BRAIN

FOREBRAIN: thalamus, hypothalamus, hippocampus, basal ganglia, amygdala, cerebral cortex…

MIDBRAIN: Superior and inferior colliculus and substantia nigra

HINDBRAIN: medulla, pons, cerebellum

We divide brain into 3 parts. From bottom to top or in other words from old to new.

1-HINDBRAIN

Pons

Cerebellum

Medulla oblongata

- HINDBRAIN
- The hindbrain includes the **cerebellum**, the **pons** and the **medulla oblongata**, which function collectively to support vital bodily processes composing the brain stem.
- The medulla is joined to the spinal cord and controls unconscious, yet essential, body functions such as breathing, swallowing, blood circulation, muscle tone, vomiting, coughing.
- Located above the medulla is the Pons which serves as a bridge to connect the brainstem and the cerebellum. Pons means bridge and it is the crossing point of the nerve fibers coming and going to the brain.

- Cerebellum

CEREBELLUM, is known for it's contribution to balance of the body and the motor coordination.

Further, we know that cerebellar damage results in attention switching difficulties between visual and auditory stimuli.

Patient also experience difficulties in timing.

-beets and dotes

2-MIDBRAIN

Superior colliculus

Inferior colliculus

Substantia nigra

- THE MID-BRAIN

Superior colliculus:

Enables organism to perform rapid reflexive actions which depend on the vision

Inferior colliculus:

Enables organism to perform reflexive actions depend on sound.

Substantia nigra:

Is the center for the 'dopamine' production. Dopamine is important for several vital functions in the brain such as mental functions and movement.

- THE FOREBRAIN
- FOREBRAIN

3- FOREBRAIN

- Cerebral cortex

and Limbic system

- FOREBRAIN
- It is the newest part of the brain. It evolved up on the midbrain and composes the cerebrum. Forebrain is consists of two cerebral hemispheres.

CEREBRAL HEMISPHERES:

Cerebrum is divided in two by the longitudinal fissure and bind together by Corpuscollosum. Cerebral hemispheres need to work together (bilaterally) to produce most of the higher cognitive functions

such as imagination, defense reactions, decision making, planning, appropriate expression of feelings, learning and memory.

- Receives info and controls muscles at the contra lateral side

Under the cerebral cortex we can find, thalamus, basal ganglia, limbic system(form a border around the brain stem)

Limbic system includes olfactory bulb, hypothalamus, hippocampus, amygdala and cingulate gyrus.

- Limbic system
- Deals with mediation and expression of emotional, motivational, sexual and social behavior and also controls and monitors internal homeostasis. In other words it deals with 4 F's. It is a group of structures working together and includes: Hypothalamus, Amygdala, Hippocampus, Septal nuclei, Cingulate, thalamic nucleus.
- LIMBIC SYSTEM
- Limbic system
- Thalamus and hypothalamus
- THALAMUS
- *Thalamus*
- It is located in the middle of the brain. This is no coincident. All the sensory information comes from different parts of the brain with afferent nerves and goes through Thalamus before they reach to the neo-cortex. Thalamus reduces or increases the amount of the information going to the neo-cortex. That way, organism can focus its attention on a certain kind of stimuli. Thalamus is connected to every part of neo-cortex with its fibers. Protects neo-cortex from being overwhelmed and acts as a filter.
- HYPOTHALAMUS
- HYPOTHALAMUS
- It is composed of a group of nuclei. Function of it is primitive and reflexive .Works with an on and off principle.
- It mediates or exerts controlling influences on eating, drinking, experience of pleasure, rage and aversion.
    - Among other nucleus of hypothalamus, Medial Hypo. Affects the parasympathetic activity (ex. Decrease heart rate). Lateral hypo. Affects the sympathetic activity(pleasure center of the organism). When lateral hypo. activated people want to eat. When had enough, medial get activated to stop its function.
- Lateral hypo. is responsible of rage and aggressive behavior. Hypo. acts for immediate relieve of tension. Have no sense of values and no expression of love or hate. Its functioning is

mechanic. It corresponds to what Freud described as ID with pleasure Principle and much of its activity is in unconscious level.

- Hypothalamus sees only inward. When Hippocampus and Amygdala develops, organism gains the ability to see outward as well. This means organism can register and recall events, people, objects and associate those with tension reduction. This is called learning. When Amygdala and hippocampus develops, organism move away from pleasure principle and become more reality oriented.
- Partly through it's nerves and partly by hypothalamic hormones, it sends messages to Pituitary gland altering it's release of hormones.

PITUITARY GLAND

It is beneath the Hypothalamus and connected to it. It gets messages from the hypo. And it synthesize hormones and release them to go to organs and other tissues in the body.

- *Septal nuclei*
- Reduce extremes of emotionality and arousal in limbic system. Amygdala promotes social behavior where Septal nuclei inhibits. When damaged in rats they try to crawl on a cat even when it is acting aggressive and hungry. When damaged in human, person go and talk to anyone about anything and over-socialize.
- *Basal ganglia*
- Basal ganglia is a term that refers to a group of nuclei. Its known role is facilitation of movement and filtering to prevent inappropriate movement in an organized movement. It sends information directly to the supplementary motor area. It also plays a role in the some higher cognitive processes. Basal ganglia gets impaired in Parkinson and Huntington disease where the consequence appears as impaired movement, memory, attention and reasoning.
- hippocampus
- *Hippocampus*
- It plays a major role in information processing. It is closely related with memory, learning, cognitive mapping and attention. When neo-cortex is highly stimulated hippocampus works slowly, monitor what has been received and encode them. After something is learned and stored, its activity diminishes. Damage to the hippocampus reduces the ability for learning and remembering. Damage to the left hippocampus disrupts verbal memory. Damage to right hippocampus disrupts emotional, visio-spatial and facial memories.
- Hippocampus and Amygdala are interdependent in regard to memory. Hippocampus mediates the amount of information which will be encoded, where Amygdala identifies emotional-motivational characteristics of this information and generates emotional rewards to reinforce learning and memory.
- amygdala

- *Amygdala*
- It is interconnected with Hypothalamus. In contrast to primitive hypothalamus, amygdala controls higher level emotional and motivational activities. Amygdala can prolong hypothalamic activity until the goal is reached. It may feel or express love, rage and fear. It is involved in attention, memory and learning.
- *Attention*: environmental surveillance.
- *Fear and aggression*: prolonged stimulation creates aggression or fear. Aggressiveness created by amygdala can exist for long period of time. It is not like hypothalamic aggression which suddenly goes on and off.
- Bilateral amygdaloid destruction causes indiscriminated sexual behavior, inability to identify emotional significance of the events and reduced aggressiveness and fearfulness. Females have bigger amygdala.