**BCS TASK-2**

**EEG AND MEG**

- The electroencephalography (EEG) and magnetoencephalography (MEG) are methods used to record the electrical and magnetic activity of the brain, respectively.

- EEG measures the voltage difference between two locations on the scalp, while MEG measures the magnetic fields generated by neuronal activity.

- EEG and MEG are based on the fact that neurons use electrical impulses to communicate and generate magnetic fields.

- EEG electrodes are mapped on the scalp in a specific way, with each electrode identified by a letter indicating the lobe or area of the brain where the signal is read from.

- EEG signals can be affected by artifacts, such as eye movement or muscle activity, which need to be identified and removed before analysis.

- Alpha oscillations, with a frequency between 8 to 13 hz, are a major rhythm observed in normal relaxed adults with closed eyes.

- It also talks about about the challenges and techniques used in measuring and analyzing brain activity using EEG and MEG.

- Electrical currents in the brain generate magnetic fields that can be measured outside the skull.

- The forward problem is about simulating the potentials at the electrode from a current source inside the brain, while the inverse problem is about localizing brain activity from the recorded electric or magnetic fields.

- EEG uses active and passive electrodes to pick up brain signals, while MEG uses superconducting quantum interference devices (SQUIDs) to measure magnetic fields.

- EEG and MEG experiments involve presenting stimuli to participants and measuring their brain responses.

- EEG and MEG offer high temporal resolution but low spatial resolution.

- Fourier transform is a mathematical technique used to transform brain signals from a function of time into a function of frequency.

**fMRI**

- fMRI (functional magnetic resonance imaging) is a neuroimaging technique that uses the BOLD (blood-oxygen-level-dependent) effect to make blood vessels visible as blood oxygenation decreases.

- It allows the study of brain dynamics at an intermediate level in live human beings, not just at the layer of neurons or the whole brain.

- There are two types of MRI: structural and functional, with the latter being based on blood oxygenation.

- MRI sequences, which can be changed in their arrangement, produce images with high resolution, optimized to produce differential contrast between tissues.

- Functional MRI produces a dynamic series of images over time, with each image taking less than 3 seconds and having lower resolution. The sequences are optimized to detect the level of oxygenation of blood or other functional characteristics.

- A typical experiment involves stimulating the subject through visual or auditory stimuli and recording several images, which are then assembled into a statistical image.

- The strength of the MRI machine is measured in Teslas, with 3-Tesla systems being the most common.

- fMRI has more spatial resolution than MEG or EEG, allowing the distinction of activity at the layer of columns or layers.

- There are many different types of MRI sequences, and they are still being discovered or crafted.

- Neurons do not have internal reserves of energy, sugar, or oxygen, and rely on a quick influx of oxygenated blood to fuel neural activity.

- Hemoglobin in red blood cells releases oxygen when it encounters deoxygenated tissue, causing distortions in the magnetic field that can be detected through fMRI.

- The blood-oxygen-level-dependent (BOLD) response, which is the interplay between blood volume, flow, and deoxyhemoglobin content, is the basis of fMRI and allows for the identification of areas of increased neural activity. There's an increase in blood volume, there  is then a decrease in deoxyhemoglobin.

- There are three types of fMRI experiments: block designs, event-related designs, and resting state experiments.

- Block designs compare different conditions, such as eyes open versus eyes closed, by comparing the blood-oxygen-level-dependent effects of collected images.

- Event-related designs compare different stimuli, such as Navon figures, by taking the activity around each stimulus and comparing them statistically according to their conditions.

- Resting state experiments measure the activity of the brain when a person is at rest and not receiving external stimuli, and study the functional connectivity between different brain regions.

- The correlation of activity between different brain regions in resting state experiments has been related to different conditions and experiments, and has become a large area of work.

**STIMULUS REPRESENTATION**

- Sensory information is integrated from the environment through senses such as vision, smell, taste, touch, and pain.

- This lecture will focus on the visual system and how sensory information is represented in the brain.

- The visual system starts in the eye and progresses to the primary visual cortex (V1) and then to higher visual cortical areas through different pathways.

- The brain can be treated as a black box, and a systems approach can be used to understand how neurons represent sensory information.

- Receptive fields are the regions of a sensory organ that are sensitive to a particular stimulus.

- In visual neuroscience, Spike Triggered Averaging is used to measure receptive fields by averaging visual stimuli in relation to the spike time of a neuron.

- Retinotopic maps illustrate how the visual field is represented at the cortical level and maintain a neighborhood relationship.

- The center and surround of a receptive field have different modulatory functions and are responsive to light increments and decrements in ON and OFF pathways.

- Receptive fields are dynamic and can change in response to changes in the environment.

- The retina and LGN have spot detector receptive fields, while neurons in higher levels of the visual hierarchy have more complex response features, such as orientation selectivity.

- Tuning curves are used to characterize the selectivity of neurons in sensory systems, such as orientation selectivity, motion direction selectivity, and spatial frequency tuning curves.

- Neurons with similar response selectivity are organized in functional maps in the visual cortex.

- The functional organization of sensory cortices is an important aspect of sensory neuroscience, as it helps to understand how sensory information is represented at the level of the brain.

**NEUROTRANSMISSION**

-The video starts with the instructor telling ud about the molecular mechanism and synaptic circuits that allow the generation of ‘motivated behaviour’. Such studies can be very useful in understanding and finding the cure of conditions like ADHD and OCD.

-Once again the basic structure of a neuron, electrically excitable cell  is discussed. Minute details about the neuron like oligodendrocites are non neuronal cells that provide mylein sheath around the axon ,which provides insulin coating and conducting velocity.

-the unequal distribution of ions on both side of the membrane of the neuron helps to create the membrane potential.At rest there is more negative ions on the inside of the membrane than outside .

-The membrane is also permeable for some ions. Action potential takes  the electrical signal from dentride to the axon. In the raising phase of the action potential , due to the rush of Na+ ions(Na+ channel) a positive flux is created.

-the transmission of synapse occurs between the pre and the post synaptic neurotransmitter due to the calcium gate which is regulated by the action potential.

-there are two types of postsynaptic receptors

 1) Ionotropic receptors (ligand ion channels)

 2)Metabotropic (G-protein) coupled receptors

-One of the most significant neurotransmitters in the brain, glutamate(excitatory neurotransmission) is essential for many physiological and cognitive functions. It is an excitatory neurotransmitter, which means that it improves signal transmission across synapses and encourages the firing of neurons.

-.Gamma-aminobutyric acid (GABA) is the main inhibitory neurotransmitter in the brain, meaning that it decreases the likelihood of neuronal firing and reduces overall neural activity.

- GABAergic neurons are widely distributed throughout the brain, and GABA signaling plays a critical role in many physiological and cognitive processes, including motor control, anxiety regulation, and sleep.

-dopamine is a biogenic amines(catechloamine).it is a neuromodulator(controls the strength of a synapse).it has a crucial role in motivation,rewardand reinforcement.

**NEURONS TO CONSCIOUSNESS**

-The video starts with the importance of diversity of the neuron.The brain can respond to a broad variety of stimuli and adapt to changing settings thanks to the many neural circuits formed by these distinct types of neurons.

- These circuits have the capacity to process and integrate information from multiple sources.

-neurons are classified into different types based on their morphology and electrophysiology.The actions and neuronal activity referred to as the neural correlates of consciousness (NCC) include many different functions, including as perception, focus, and introspection. One must comprehend the NCC in order to properly understand consciousness, which is still an enigmatic phenomenon.

-inorder to understand how the brain perceive vision and how the short term memory is stored we need to understand how data is stored in the brain at the cellular level

- recurrency and heterogeneity is what makes a human brain different from a digital computer.

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