Circuitary and Study Methods of Neural Circuit

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Perspective

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DESCRIPTION

A neural circuit is a group of neurons connected by synapses to perform a certain function when stimulated. It is sometimes referred to as a Biological Neural Network (BNN). Large-scale brain networks are constructed by the connections between numerous neuronal circuits. Artificial neural networks were created with inspiration from brain circuits, despite substantial differences. The cortico-basal ganglia-thalamo-cortical loop consists of a number of brain circuits. These circuits transmit data from the cortex to the thalamus, basal ganglia, and back to the cortex. The striatum, the main component of the basal ganglia, is thought to have its own intrinsic microcircuitry. Central pattern generators, a type of neural circuit in the spinal cord, are in charge of regulating motor instructions used in rhythmic behaviors. The actions of walking, urinating, and ejaculating are rhythmic behaviors. Different spinal interneuron groups make up the central pattern generators.

One neuron makes synapses with a variety of postsynaptic cells in a divergent circuit. One neuron can excite up to thousands of cells due to these synapses with numerous other cells. The ability of a single motor neuron to initially excite thousands of muscle fibers serves as an illustration of this. A converging circuit combines inputs from various sources into a single output that influences a single neuron or a group of neurons. The respiratory center of the brainstem, which responds to a variety of inputs from many sources by discharging an appropriate breathing rhythm, is an example of this type of circuit.

Study methods

To examine the activity of brain circuits and networks, various neuroimaging techniques have been created. It is common to employ "brain scanners" or functional neuroimaging to study the anatomy or physiology of the brain, either to more accurately detect brain injury with detailed images or to look at how various brain regions are activated in relation to one another. These techniques could include Computed Axial Tomography (CAT) scans, Brain Positron Emission Tomography (brain PET), and Functional Magnetic Resonance Imaging (FMRI). In order to better understand how the activation of specific brain areas relates to a task, functional neuroimaging uses specialized brain imaging tools to capture scans from the brain, typically while a person is performing the task. Functional neuroimaging includes Electroencephalography (EEG), PET, and fMRI, which assesses hemodynamic activity (using BOLD-contrast imaging), which is strongly linked to cerebral activity.

Different representational, information processing, and signal transmission hypothese are tested using connectionist models. Lesioning experiments in these models, like artificial neural networks, in which portions of the nodes are purposefully destroyed to see how the network functions, can also provide crucial understandings of how certain cell assemblies function. Similar to this, simulating malfunctioning neurotransmitters in neurological diseases (such as dopamine in Parkinson's patients' basal ganglia) can provide information about the underlying causes of the patterns of cognitive deficiencies seen in that patient group.

A thorough discussion has led to the current equilibrium between the connectionist approach and the single-cell method in neurobiology. Barlow launched the single neuron revolution in 1972, stating that "our perceptions are caused by the activity of a rather small number of neurons selected from a very large population of predominantly silent cells". The grandmother cell concept, which was proposed two years earlier, served as inspiration for this method. The "five dogmas" of neuron doctrine were developed by Barlow. These theories are developed and modified by recent research on "grandmother cells" and sparse coding phenomena. The medial temporal lobe (the hippocampus and surrounding cortex) of the brain, where the single cell tests were conducted, was electroded intracranially. When the basal ganglia are involved, neuronal circuitries can occasionally develop pathologies and lead to issues, as in Parkinson's disease. Papez circuit issues can potentially result in Parkinson's disease and other neurodegenerative diseases.