Mind is the ability of an agent to find invariances and regularities in their environment, while the brain is made up of material and has its own chemistry and physiology. The brain has a high energy budget, and has distinct parts . To understand how the dynamics of the brain gives rise to mind, it is necessary to dig a bit deeper. Neurons are very specialized cells that have distinct structures, such as dendrites and axons.

When the conductance of the membrane is changed, a neuron responds with an action potential, which is the currency of information processing in the brain. Neurons come in a variety of shapes. There are 86 billion neurons in the human brain, but this is not enough to make the brain complex. The second important component of the brain's hardware is the connections, called synapses. These connections are of two types: electrical and chemical.

The neocortex is organized in 6 layers and has a specific inter-layer connectivity, with information arriving at layer 4, being transmitted to layer 2/3, and then sent back to layer 5/6. Horizontal connectivity is also observed, with neurons not making arbitrary connections, but their connection probability decreasing as a function of distance.

The brain is complex due to its connections, which are made by traveling activity along the axons and have a conduction speed of 220 Miles per hour. These connections are largely determined by the genetic makeup of the brain and are species-specific and individual-specific. The brain is complex in that its connections are delayed, there is dynamic change in the connection strength, and there is structure to the connectivity.

To approach the brain function problem, it is important to relate the behavior to brain activity. Animals are trained to perform specific tasks, and this approach is intuitive. Their are various methods used to record brain activity and track behavior. These methods include perturbation experiments, such as lesions or brain diseases, which can create a controlled reversible lesion in specific parts of the brain. Additionally, experiments have been designed to test whether a certain machine learning algorithm could be implemented in the brain, such as Reinforcement Learning.

Psychophysics is a study of the relationship between stimulus and sensation, and is important for designing visual displays and trichromacy. Psychophysics was able to make powerful predictions that were later borne out by physiology, such as the Weber-Fechner law and Just Noticeable Difference (JND). The idea of a logarithmic encoding of stimulus intensity is proposed by Weber's law, which states that the change in stimulus intensity required to bring about a given change in percept is proportional to the stimulus intensity itself.

However, this conclusion is wrong as the underlying internal signal is noisy and requires an internal decision criterion to determine if the observer saw light or not. The decision criterion shifts the psychometric function left and right, so a two-interval forced-choice detection task is a better way to test sensitivity to light. The performance is always at 50 for zero signal. The threshold is a value that can be measured by the method of constant stimuli, which is a gold standard method that is time consuming and inefficient. It is determined by the proportion of reporting the correct interval as a function of the stimulus intensity.

Staircase techniques try to collect data at stimulus intensities close to the threshold, which involves a large number of trials. They start with a high stimulus intensity to make the task easy, then reduce it until they make a mistake. The staircase method is faster than the method of constant stimuli and can be used to compare two different stimuli. It can also be used to detect perceptual biases, such as optical illusions. The point of subjective equivalence is the point at which each response is equally likely, and can be measured using the method of constant stimuli.

There are many types of behavioral readouts in neuroscience, including decision making, complex movements, learning and memory, and internal state. The Two Alternative Forced Choice Task is a common behavioral paradigm to study decision making. Animals can indicate their decisions by physically turning the wheel, licking at one or the other, moving and poked their noses into one of the two ports, or using a joystick.

The mouse in the task licks one spout or the other to indicate its decision of where the stimuli are. The handles and spouts have sensors that record when the mouse grabs them and when the mouse licks them. Examples include Body Part Tracking and DeepLabCut, which automate the process of tracking body parts over time. This study used a lower dimensional representation of the video, 200 numbers at each time point, and Wide Field Imaging to record activity from the brain.

They found that the cortex-wide activity was dominated by movement, especially uninstructed movements. Bob Datta at Harvard developed a depth camera and analysis pipeline to extract behavioral syllables from videos. He also used a Hidden Markov model to extract chunks of time where the mouse was doing something specific. Navigation is a behavioral readout of the mouse's learning and memory, and natural behaviors can be used to measure fear. Eye tracking can also be used to report where an animal is looking in the visual field. Monkeys parse faces similarly to humans.

Anne Churchland is a researcher at UCLA in Los Angeles, California who studies the neural circuits that support decision making. Her lab has wide-field imaging to measure activity across the dorsal cortex as animals are making decisions. Two students are doing an experiment to understand the neural responses that support decision making.

The wide-field imaging rig is a head-fixed setup that allows for the delivery of auditory and visual stimuli to the animal while it is performing a task. The rig has two spouts with two audio-visual stimuli coming from the left side and the right side, and a circuit board that interacts with the behavior. The wide-field setup allows for the recording of activity with the wide-field during behavior. The wide-field imaging setup consists of two modules: an excitation module with a blue LED sending light into the mouse brain and a violet LED exciting GCaMP, and a filter where the light passes through and into a camera.

The data is collected using a cloud-based platform called NeuroCAAS, which allows for cloud-based computing even on large data sets.

Neurons are the basic units of the nervous system and allow action potentials to be generated. They have dendrites, cell bodies, Axon Hillocks, and Synapses, and are propagated along the axon all the way to the Axon Terminals. Action potentials are electrical signals triggered by a rapid change in the polarity of the membrane potential, which is caused by a differential distribution of ions on either side of the membrane. Action potentials are "all-or-nothing" because when they exceed a threshold point, they become a stereotypical positive upstroke and return to the resting membrane potential. An analogy is like flushing toilets.Action potentials have a refractory period, meaning there is a maximum number of times they can be activated in a minute. Recording spikes from neurons requires amplified signals, which can be done with a conducting metal or electrode. Spikes are generated by individual neurons and have a set intensity and duration. The nervous system is plastic and can change in response to previous activity, such as drugs, manipulations, and experience. Neurons can be connected to each other through forward excitation, feedback mechanisms, and self-perpetuating systems. Neurons are the basic units of the nervous system, and their properties can change and their connections can give rise to various spike patterns.