Chapter 1

Introduction to Cognitive Psychology

The word ‘cognition’ is derived from the Latin word *cognoscere*, meaning “to know” or “to come to know”. Thus, cognition includes the activities and processes concerned with the acquisition, storage, retrieval and processing of knowledge. In other words, it might include the processes that help us to perceive, attend, remember, think, categorize, reason, decide, and so on.

Cognitive psychology, as the name suggests, is that branch of psychology that deals with cognitive mental processes. Sternberg (1999) defined Cognitive psychology as that which deals with how people perceive, learn, remember, and think about information.” In 2005, Solso gave another definition of Cognitive psychology as the study of processes underlying mental events. In general, Cognitive psychology can thus be defined as that branch of psychology that is concerned with how people acquire, store, transform, use and communicate language.

The cognitive psychologists study the various cognitive processes that make up this branch. These processes include **attention**, the process through which we focus on some stimulus; **perception**, the process through which we interpret sensory information; **pattern recognition**, the process through which we classify stimuli into known categories; and **memory**, the process through which information is stored for later retrieval, and so on. Thus, the work of cognitive psychologists is extended to a number of areas, which can be depicted as follows –

A Brief History of Cognitive Psychology

The roots of cognitive psychology can be traced back much further, and is intimately intertwined with the history of experimental psychology. This leads back to the time period when the empiricist, rationalist, and structuralist schools of thought which included philosophical works of Plato, Aristotle that dealt with the philosophy of mind, and also to the later works of Wundt, and Titchener involving introspection. However, for some period, the behaviorist school of thought dominated all the others, and the focus was shifted from thought to behavior.

Around the time between the 1950s and 1970s, the tide began to shift against behavioral psychology to focus on topics such as attention, memory and problem-solving. The formal discipline of “Cognitive Psychology” started in the mid-1900s during the cognitive revolution, and the term ‘cognitive psychology’ did not emerge until 1967. Dissatisfaction with behaviorism, World War II, and the growing technological advances in other fields such as computer sciences were a few major reasons behind the Cognitive revolution. The mental processes regained their focus in psychology, and their measurement began in objective, quantifiable methods.

In recent times, a number of different disciplines have started to come together and collaborate such as the fields of psychology, artificial intelligence, linguistics, philosophy, anthropology, and neuroscience, in order to gain a better insight into the field of cognitive psychology.

Approaches to Cognitive psychology

A number of different approaches have been proposed in order to better understand the field of cognitive psychology. Each of these approaches emphasizes a different aspect and highlight distinct features underlying the cognitive processes. These methods provide us with an insight into how the human mind functions by giving us a general idea about the workings of the basic cognitive processes that we engage in. Broadly, there are four major approaches that try to explain the various cognitive
processes by highlighting the different important features. These approaches are: Experimental Cognitive Psychology, Computational Cognitive Science, Cognitive Neuropsychology, and Cognitive Neuroscience.

**Experimental Cognitive Psychology**
This approach involves conducting tightly controlled experiments under laboratory conditions on healthy individuals. It generally includes experiments that designed in such a way that they might disrupt the cognitive processes and reveal their workings. The findings obtained through such experiments then lead to formulation of the theories, which in turn lead to testable claims. For example, a researcher wants to examine the effect of arousal on reaction time. He uses the experimental approach, and the reaction time is assessed through a machine where the buttons light up and the time to respond is measured. The arousal is also assessed through heart rate measurement, under the following conditions; after rest, after cognitive overload, after exercise, after caffeine, and after both exercise and caffeine. The results obtained through such experimental methods can thus lead to formulation of some theories, which later can be tested.

**Computational Cognitive Science**
This approach involves computational modeling through the recreation of some of the aspects of human cognition in the form of some computer program, or formula in order to predict behavior in novel situations. In other words, this approach basically involves creating computer based models of human cognitive functions, as well as some work on artificial intelligence.

**Cognitive Neuropsychology**
This approach to cognition investigates the various cognitive processes by studying the people
who have suffered brain damage, and to find out whether damage to a particular brain region would result in a specific cognitive impairment. For example, damage to region X disrupts ability Y, and the people who have lost ability Y also have problems with ability. Thus, such studies involving people with brain damages help us to make assertions regarding the healthy brain functions.

However, such studies are difficult and cannot be manipulated according to the wishes of the researcher as it would be unethical to cause damage to a particular brain region of a person so that its role in a specific cognitive function can be observed. Also, if a person has suffered damage to several brain areas, then the interpretation of the resultant findings is difficult.

- **Cognitive Neuroscience**

This approach has gained popularity over the past decade or so, and involves brain-imaging devices to study cognitive functions. This can help to discover where these processes occur in the brain, and when. In other words, this approach involves using brain imaging and brain anatomy to study 'live' cognitive functioning in healthy individuals. As the technology improves, these studies are becoming more influential and potentially useful. Some of the methods used in the cognitive neuroscientific approach include:

  - Single Unit Recording
  - Event Related Potentials (ERPs)
  - Positron Emission Tomography (PET)
  - (Functional) Magnetic Resonance Imaging (fMRI, MRI)
  - Magneto-encephalography (MEG)
  - Transcranial magnetic stimulation (TMS)

However, these techniques might be of questionable use with high-order functioning which might not be organized in a concise way. Also, if data from several individuals is averaged the interpretations become accordingly blunt. Sometimes, when using these methods, tendency for research to be conducted is just for the sake of research. Papers can often be lacking any theoretical basis, and result in ad hoc hypotheses. Furthermore, threshold levels need to be set to disregard noise, and these levels are a debatable issue.

**Information processing Theory**

Since the 1960s and 1970s, the information processing approach has dominated the field of cognitive psychology. Basically, this approach draws an analogy between cognitive processing in humans and processing of information by a digital computer. This theory aims to explain the sequence of transformations that input information undergoes in order for a computer/mind to generate an output response. The researchers who follow this approach assume that the information is processed in stages and that it is then stored in specific places while being processed. The figure given below is a typical example of an information processing model.
cognitive abilities of a person can be thought of as 'systems' of interrelated capacities, and finding out the relationship between these capacities can explain how individuals go about performing the specific cognitive tasks. This theory also assumes that like computers, people can also perform numerous cognitive feats by applying only a few mental operations to symbols.

- **Bottom–up Processing** – In bottom-up processing, the stimulus reaches an inactive, unprepared organism, and the processing is directly affected by the stimulus input. In other words, the processing is essentially driven by what information an individual acquires from his or her environment. So here, the processing starts from the input level which is invariably the lower level of processing, and then goes on to its interpretation.

- **Serial Processing** – As the name suggests, in serial processing, the processing of information happens ‘serially’. The processing happens one by one, and one process is completed before the next one can start.

**Parallel Distributed Processing theory**

The parallel-distributed processing model states that information is processed simultaneously by several different parts of the cognitive system, rather than sequentially. In this type of processing model, the information that is received from the environment is processed in a number of different locations simultaneously, and then stored.

In 1986, the parallel distributed processing model was further extended. Rumelhart and McClelland extended it, and proposed the **Connectionistic approach** to processing. According to this, that information is stored in multiple locations throughout the brain in the form of networks of connections, called 'Nodes'. In this model, cognition is basically thought of as a network of connections among a number of simple processing units. Each unit is connected to other units in a large network, and has some level of activation at a given moment of time. This level of activation is dependent on the input that the unit receives, both from the environment as well as from the other units to which it is connected. Thus, according to the Connectionistic framework, the various cognitive processes are a result of the different levels of activation, and a central processor is not required to direct the flow of information from one process or storage area to another.

**Research methods in Cognitive Psychology**

A number of methods are employed in cognitive psychology in order to get an insight into the workings of higher mental processes.
Experiments —

In an experiment, a researcher manipulates a variable in order to see its effect on another variable. For example, suppose a person wants to know whether background noise affects performances on quantitative problems. One way of studying this would be to take a group of people and randomly assign them to two different groups, a no-noise group and a white-noise group. The first group is asked to solve the problems in a quiet environment and the second group tries to solve the problems whilst being exposed to white noise. In this case, the presence/absence of white noise is referred to as the independent variable. Our outcome measure is referred to as the dependent variable.

The random assignment of participants and the ability to include variables of interest while excluding many unwanted factors mean that the true experiment is a particularly powerful kind of design. However, not all experiments involve the comparison of different groups. For instance, in the earlier example, one could have used a single group of people, but asked them all to take part in the two conditions of the study. The two types of design are referred to as between-subjects and within-subjects, respectively.

Psychobiological research —

Some researchers investigate the relationship between cognition and the brain's structures and activities. This is psychobiological research. One way of looking at such relationships is to conduct post mortem studies, to compare the brains of normal individuals with those who were known to have some kind of cognitive deficit. Also, one can also observe the performance of brain damaged individuals and their cognitive deficits. Researchers can also monitor an individual doing a cognitive task, with the help of various measures such as PET, MRI, or fMRI.

Case Studies —

Case studies are intensive investigations of individuals, usually people of exceptional ability or people with some sort of deficit. These studies may examine archival records, interviews, direct observation, or participant-observations.

Naturalistic Observation —

Another methodology open to researchers is to observe people in real-life settings, such as at home or at work. Observations may be done with the knowledge and consent of those being watched, or they may be covert, in which case people are not aware that they are being watched. The latter type of observation obviously requires the researcher to give particular thought to ethical considerations.

Computer Simulations —

Computer simulations aim to imitate aspects of human functioning. A particular cognitive theory may be implemented in a computer program. If the program runs successfully and produces outputs that resemble human responses, then one might conclude that the theory is coherent and plausible.

Application of Cognitive Psychology

Cognitive psychology is that branch of psychology that deals with the study of higher level mental
processes. Some of the areas in which this branch finds its application in the real world are listed as follows –

- Human Error
- Driving behavior
- Product design
- Visual behavior
- Object / face recognition
- Human-machine interaction