NATURE OF MEMORY

Memory refers to retaining and recalling information over a period of time, depending upon the nature of cognitive task you are required to perform. It might be necessary to hold an information for a few seconds. For example, you use your memory to retain an unfamiliar telephone number till you have reached the telephone instrument to dial, or for many years you still remember the techniques of addition and subtraction which you perhaps learned during your early schooling. Memory is conceptualised as a process consisting of three independent, though interrelated stages. These are encoding, storage, and retrieval. Any information received by us necessarily goes through these stages.

(a) *Encoding* is the first stage which refers to a process by which information is recorded and registered for the first time so that it becomes usable by our memory system. Whenever an external stimulus impinges on our sensory organs, it generates neural impulses. These are received in different areas of our brain for further processing. In encoding, incoming information is received and some meaning is derived. It is then represented in a way so that it can be processed further.

(b) *Storage* is the second stage of memory. Information which was encoded must also be stored so that it can be put to use later. Storage, therefore, refers to the process through which information is retained and held over a period of time.

(c) *Retrieval* is the third stage of memory. Information can be used only when one is able to recover it from her/his memory. Retrieval refers to bringing the stored information to her/his awareness so that it can be used for performing various cognitive tasks such as problem solving or decision-making. It may be interesting to note that memory failure can occur at any of these stages. You may fail to recall an information because you did not encode it properly, or the storage was weak so you could not access or retrieve it when required.

INFORMATION PROCESSING APPROACH:

THE STAGE MODEL

Initially, it was thought that memory is the capacity to store all information that we acquire through learning and experience. It was seen as a vast storehouse where all information that we knew was kept so that we could retrieve and use it as and when needed. But with the advent of the computer, human memory came to be seen as a system that processes information in the same way as a computer does. Both register, store, and manipulate large amount of information and act on the basis of the outcome of such manipulations. If you have worked on a computer then you would know that it has a temporary memory (random access memory or RAM) and a permanent memory (e.g., a hard disk).

Based on the programme commands, the computer manipulates the contents of its memories and displays the output on the screen. In the same way, human beings too register information, store and manipulate the stored information depending on the task that they need to perform. For example, when you are required to solve a mathematical problem, the memory relating to mathematical operations, such as division or subtraction are carried out, activated and put to use, and receive the output (the problem solution). This analogy led to the development of the first model of memory, which was proposed by Atkinson and Shiffrin in 1968. It is known as Stage Model.

MEMORY SYSTEMS: SENSORY, SHORT-TERM AND LONG-TERM MEMORIES

According to the Stage Model, there are three memory systems : the Sensory Memory, the Short-term Memory and the Long-term Memory. Each of these systems have different features and perform different functions with respect to the sensory inputs. Let us examine what these systems are:

Sensory Memory

The incoming information first enters the *sensory memory*. Sensory memory has a large capacity. However, it is of very short duration, i.e. less than a second. It is a memory system that registers information from each of the senses with reasonable accuracy. Often this system is referred to as sensory memories or sensory registers because information from all the senses are registered here as exact replica of the stimulus. If you have experienced visual after-images (the trail of light that stays after the bulb is switched off) or when you hear reverberations of a sound when the sound has ceased, then you are familiar with iconic (visual) or echoic (auditory) sensory registers.

Short-term Memory

You will perhaps agree that we do not attend to all the information that impinge on our senses. Information that is attended to enters the second memory store called the *short-term memory* (abbreviated as STM), which holds small amount of information for a brief period of time (usually for 30 seconds or less). Atkinson and Shiffrin propose that information in STM is primarily encoded acoustically, i.e. in terms of sound and unless rehearsed continuously, it may get lost from the STM in less than 30 seconds. Note that the STM is fragile but not as fragile as sensory registers where the information decays automatically in less than a second.

Long-term Memory

Materials that survive the capacity and duration limitations of the STM finally enter the *long-term memory* (abbreviated as LTM) which has a vast capacity. It is a permanent storehouse of all information that may be as recent as what you ate for breakfast yesterday to as distant as how you celebrated your sixth birthday. It has been shown that once any information enters the long-term memory store it is never forgotten because it gets encoded semantically, i.e. in terms of the meaning that any information carries. What you experience as forgetting is in fact retrieval failure; for various reasons you cannot retrieve the stored information. You will read about retrieval related forgetting later in this chapter.

So far we have only discussed the structural features of the stage model but how does information travel from one store to another? As an answer to this question, Atkinson and Shiffrin propose the notion of control processes which function to monitor the flow of information through various memory stores. As suggested earlier, all information which our senses receive are not registered; if that be the case, imagine the kind of pressure that our memory system will have to cope with. Only that information which is attended to enters the STM from sensory registers and in that sense, *selective attention,* is the first control process that decides what will travel from sensory registers to STM. Sense impressions, which do not receive attention, fade away quickly. The STM then sets into motion another control process of maintenance rehearsal to retain the information for as much time as required. As the name suggests, these kinds of rehearsals simply maintain information through repetition and when such repetitions discontinue the information is lost. Another control process, which operates in STM to expand its capacity, is Chunking. Through chunking it is possible to expand the capacity of STM which is otherwise 7+2. For example, if you are told to remember a string of digits such as 194719492004 (note that the number exceeds the capacity of STM), you may create the chunks as 1947, 1949, and 2004 and remember them as the

year when India became independent, the year when the Indian Constitution was adopted, and the year when the tsunami hit the coastal regions of India andSouth East Asian countries.

From the STM, information enters the long-term memory through elaborative rehearsals. As against maintenance rehearsals, which are carried through silent or vocal repetition, this rehearsal attempts to connect the 'to be retained information' to the already existing information in long-term memory. For example, the task of remembering the meaning of the word 'humanity' will be easier if the meanings of concepts such as 'compassion', 'truth' and 'benevolence' are already in place. The number of associations you can create around the new information will determine its permanence. In elaborative rehearsals one attempts to analyse the information in terms of various associations it arouses. It involves organisation of the incoming information in as many ways as possible. You can expand the information in some kind of logical framework, link it to similar memories or else can create a mental image.

Experiments, which were carried out to test the stage model of memory, have produced mixed results. While some experiments unequivocally show that the STM and LTM are indeed two separate memory stores, other evidences have questioned their distinctiveness. For example, earlier it was shown that in the STM information is encoded acoustically, while in LTM it is encoded semantically, but later experimental evidences show that information can also be encoded semantically in STM and acoustically in LTM.

Shallice and Warrington in the year 1970 had cited the case of a man known as KF who met with an accident and damaged a portion of the left side of his cerebral hemisphere. Subsequently, it was found that his long-term memory was intact but the short-term memory was seriously affected. The stage model suggests that information are committed to the long-term memory via STM and if KF's STM was affected, how can his long-term memory be normal? Several other studies have also shown that memory processes are similar irrespective of whether any information is retained for a few seconds or for many years and that memory can be adequately understood without positing separate memory stores. All these evidence led to the development of another conceptualization about memory – the levels of processing model of memory.

Levels of Processing

The levels of processing view was proposed by Craik and Lockhart in 1972. This view suggests that the processing of any new information relates to the manner in which it is perceived, analysed, and understood which in turn determines the extent to which it will eventually be retained. Although this view has undergone many revisions since then, yet its basic idea remains the same. Let us examine this view in greater detail.

Craik and Lockhart proposed that it is possible to analyse the incoming information at more than one level. One may analyse it in terms of its physical or structural features. For example, one might attend only to the shape of letters in a word say *cat* – in spite of whether the word is written in capital or small letters or the colour of the ink in which it is written. This is the first and the shallowest level of processing. At an intermediate level one might consider and attend to the phonetic sounds that are attached to the letters and therefore the structural features are transformed into at least one meaningful word say, a word *cat* that has three specific letters. Analysing information at these two levels produces memory that is fragile and is likely to decay rather quickly. However, there is a third and the deepest level at which information can be processed. In order to ensure that the information is retained for a longer period, it is important that it gets analysed and understood in terms of its meaning. For instance, you may think of cat as an animal that has furs, has four legs, a tail, and is a mammal. You can also invoke an image of a cat and connect that image with your experiences. To sum up, analysing information in terms of its structural and phonetic features

amounts to shallower processing while encoding it in terms of the meaning it carries (the semantic encoding) is the deepest processing level that leads to memory that resists forgetting considerably.

Understanding memory as an outcome of the manner in which information is encoded initially has an important implication for learning. This view of memory will help you realise that while you are learning a new lesson, you must focus on elaborating the meaning of its contents in as much detail as possible and must not depend on rote memorisation. Attempt this and you will soon realise that understanding the meaning of information and reflecting on how it relates to other facts, concepts, and your life experiences is a sure way to long-term retention.

Types of Long-Term Memory

Short-term memory is now seen as consisting of more than one component (working memory). In the same way it is suggested that long-term memory too is not unitary because it contains a wide variety of information. In view of this, contemporary formulations envisage longterm memory as consisting of various types. For instance, one major classification within the LTM is that of Declarative and Procedural (sometimes called nondeclarative) memories. All information pertaining to facts, names, dates, such as a rickshaw has three wheels or that India became independent on August 15 1947 or a frog is an amphibian or you and your friend share the same name, are part of declarative memory. Procedural memory, on the other hand, refers to memories relating to procedures for accomplishing various tasks and skills such as how to ride a bicycle, how to make tea or play basketball. Facts retained in the declarative memory are amenable to verbal descriptions while contents of procedural memory cannot be described easily. For example, when asked you can describe how the game of cricket is played but if someone asks you how do you ride a bicycle, you may find it difficult to narrate.

Tulving has proposed yet another classification and has suggested that the declarative memory can either be Episodic or Semantic.

Episodic memory contains biographical details of our lives. Memories relating to our personal life experiences constitute the episodic memory and it is for this reason that its contents are generally emotional in nature. How did you feel when you stood first in your class? Or how angry was your friend and what did s/he say when you did not fulfil a promise? If such incidents did actually happen in your life, you perhaps will be able to answer these questions with reasonable accuracy. Although such experiences are hard to forget, yet it is equally true that many events take place continuously in our lives and that we do not remember all of them. Besides, there are painful and unpleasant experiences which are not remembered in as much detail as pleasant life experiences.

Semantic memory, on the other hand, is the memory of general awareness and knowledge. All concepts, ideas and rules of logic are stored in semantic memory. For instance, it is because of semantic memory that we remember the meaning of say 'non-violence' or remember that 2+6=8 or the STD code of New Delhi is 011 or that the word *'elaphant'* is misspelt. Unlike episodic memory this kind of memory is not dated; you perhaps will not be able to tell when you learnt the meaning of nonviolence or on which date you came to know that Bangalore is the capital of Karnataka. Since the contents of semantic memory relate to facts and ideas of general awareness and knowledge, it is affect-neutral and not susceptible to forgetting.

Exercise 1

1. Memory always involves retaining information for many years only. F
2. Memory consists of three interrelated stages: encoding, storage, and retrieval.
3. Encoding refers to the process of bringing stored information into conscious awareness. F
4. Storage is the process through which information is retained over a period of time.
5. Memory failure can occur due to problems in encoding, storage, or retrieval.

Exercise 2

1. How do you think the analogy between human memory and computer memory (RAM and hard disk) helps us better understand the way we process and store information?
2. What are some examples in your daily life where you notice the human memory system working like a computer, processing information and providing outputs?
3. Atkinson and Shiffrin proposed the Stage Model of memory in 1968. How do you think their model compares to more modern theories of memory, and what might be some limitations of the Stage Model?

Exercise 3

1. Sensory memory registers information from the senses as an exact replica of the stimulus. T
2. Short-term memory (STM) has a large capacity and stores information for long periods of time.
3. Information in short-term memory is primarily encoded visually.
4. Once information enters long-term memory, it is always available for retrieval, and forgetting is rare.
5. Maintenance rehearsal involves organizing information into meaningful chunks to expand short-term memory capacity.
6. Elaborative rehearsal helps transfer information from short-term memory to long-term memory by connecting new information to existing knowledge. T
7. Information is automatically transferred from sensory memory to short-term memory without attention.
8. Selective attention is a control process that determines which information from sensory memory enters short-term memory. T
9. 9In the case of KF, his long-term memory was affected after a brain injury, while his short-term memory remained intact.
10. The Stage Model of memory suggests that short-term memory (STM) is a temporary storage system before information enters long-term memory. T

Exercise 4

1. How does focusing on the meaning of new information (semantic encoding) help with long-term retention, compared to simply memorizing facts or structures?
2. Can you think of a time when analyzing information at a deeper level helped you remember something more effectively? How did you approach it?
3. Why do you think shallow processing (e.g., focusing on the physical features of a word) might lead to quicker forgetting, while deep processing promotes longer-lasting memories?
4. What strategies could you apply to enhance your learning by using deep processing techniques, such as relating new information to your own experiences or other knowledge you already have?

Exercise 5

1. Declarative memory consists of facts, dates, and names, while procedural memory involves tasks and skills that are difficult to describe verbally. T

2. Episodic memory stores general knowledge and facts, such as mathematical rules or historical events.

3. Semantic memory is typically emotional in nature and contains memories of personal life experiences.

4. Procedural memory is easier to describe verbally because it deals with factual knowledge and general awareness.

5. According to Tulving, episodic memory is the type of memory that contains biographical details and personal life experiences. T