1

LEARNING, FORGETTING AND IMAGERY- I

Unit Structure

1.0 OBJECTIVES

- To understand the concept of Learning and learning theories
- To understand the process of encoding, storage and retrieval

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- To understand the concept of classical conditioning with experiments
- To understand the concept of operant/Instrumental conditioning with experiments

1.1 INTRODUCTION

As humans, we are all concerned with learning and remembering new information so that we can apply it when needed. Such as acquiring concepts while studying and attempting to recall the material in order to use it in the classroom, in exams, or in everyday life or learning to play guitar. In everyday life, we frequently struggle to remember passwords and phone numbers. On the other hand, we all often remember with the untimely deaths of performers and celebrities.

This entire process is linked to memory. As we will see, many models for memory have been proposed to explain its strengths and weaknesses. Memory often works as a room to store the learned information.

1.1.2 Learning:

Psychologists often define learning as any relatively permanent change in behaviour as a result of practice and experience.

Primary theories of Learning:

To explain how and why people behave the way they do, a variety of learning theories have arisen. Environmental impacts on the learning process are central to these learning theories. Associations, reinforcements, punishments, and observations are examples of environmental influences.

The following are some of the most common learning theories:

- Classical conditioning
- Operant conditioning
- Social learning

Let's start by taking a closer look at each theory and then comparing them to one another.

1.2 HOW DOES CLASSICAL CONDITIONING WORK?

Learning through Classical conditioning

The theory of classical conditioning comes from a school of thought in Psychology known as behaviourism.

Behaviourism is based on the assumption that:

1. All learning occurs through interactions with the environment
2. The environment shapes behaviour

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Although the concept of classical conditioning has had a significant impact on behaviourism, the man who discovered it was not a psychologist. During his investigations on the digestive systems of dogs, a Russian physiologist named Ivan Pavlov discovered the principles of classical conditioning. Before being fed, the dogs in Pavlov's trials began to salivate whenever they saw the white coats of his lab assistants.

So, how does classical conditioning explain learning? Learning occurs when an association is formed between a previously neutral stimulus and a naturally occurring stimulus, according to classical conditioning principles. In Pavlov's experiments, for example, he combined the natural stimulus of food with the sound of a bell. The dogs would naturally salivate in response to food, but after food was followed by sound of bell multiple times, the dogs would salivate to the sound of the bell alone.

It is necessary to learn the fundamental concepts of classical conditioning in order to gain a better understanding of how it works. The formation of a connection between two stimuli results in a trained response in classical conditioning. This procedure is divided into three stages.

1.2.1 Stage -1: Before Conditioning:

The initial step in the classical conditioning process is to find a naturally occurring stimulus that will elicit a response automatically. A naturally occurring response is the food, in which response the dog naturally salivates. The unconditioned stimulus (UCS) causes an unconditioned response (UCR) at this step of the process. For example, presenting food (the UCS) causes a salivation response to occur naturally and effortlessly (the UCR). There is also a neutral stimulus at this point that has no effect. This neutral stimulus will not evoke a reaction unless it is combined with the unconditional stimulus (UCS).

Let's look at the two critical components of this stage.

The Unconditional stimulus (UCS) is the one that evokes a response in a consistent, natural, and instinctive manner. When you smell one of your favourite foods, for example, you may become really hungry. The fragrance of the meal is the unconditioned stimulus in this case.

The unconditional response (UCR) is an unlearned response to an unconditioned stimulus that occurs naturally. The unconditioned reaction in our example is a sensation of hunger triggered by the smell of food.

(An unconditioned stimulus is matched with an unconditioned response in the preconditioning phase. After that, a neutral stimulus is introduced.)

1.2.2 Stage -2 During Conditioning

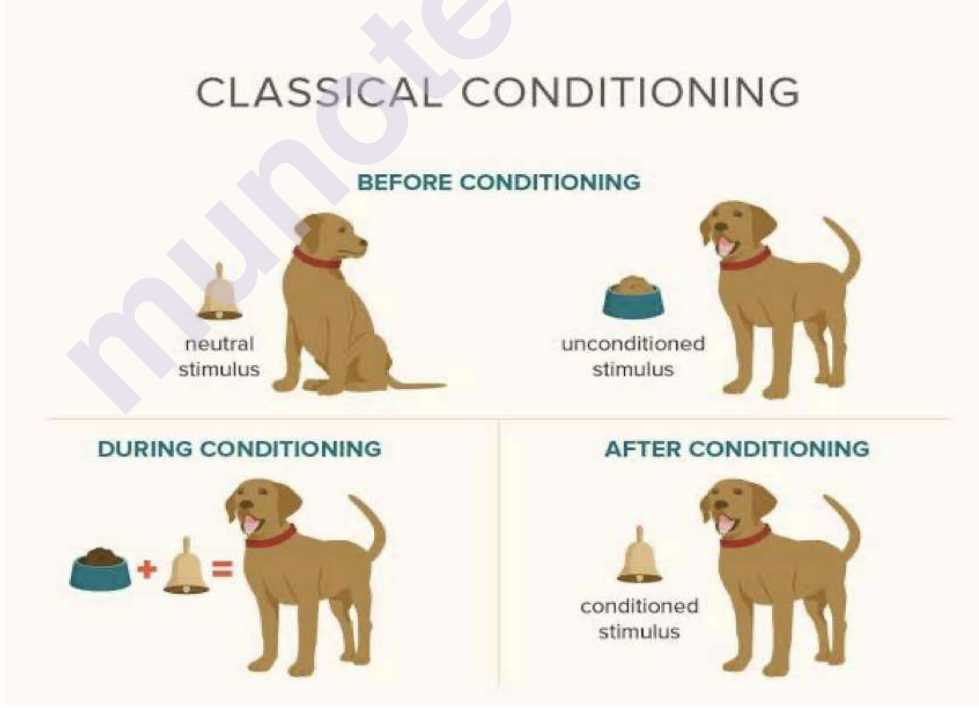
The previously neutral stimulus is repeatedly matched with the Unconditioned Stimulus (UCS) during the second stage of the classical conditioning process. The previously neutral stimulus creates an association as a result of this pairing. The previously neutral stimulus is now referred to as the Conditioned stimulus (CS). This stimulus has now

been conditioned into the subject's response. The Conditioned stimulus (CS) is a previously neutral stimulus that has been paired with unconditioned stimulus multiple times and eventually triggers a Conditioned response (CR). Letsassume that in this case when you smell your favourite food, a whistling sound is also made. Sound of whistle is neutral stimulus here. Similarly, sound of bell or white lab coats were neutral stimuli in Pavlov's experiment.

(During the conditioning phase, a neutral stimulus is paired with an Unconditioned stimulus. The neutral stimulus eventually becomes the Conditioned stimulus)

1.2.3 Stage-3 After Conditioning

Once the UCS and the CS have formed a relationship, the Conditioned stimulus alone will elicit a response even if the unconditioned stimulus is not present. The Conditioned response (CR) is the resultant response.The learnt response to a previously neutral stimulus is known as the Conditioned response. The Conditioned response in our scenario would be to feel hungry when you hear the whistle. IN Pavlov's experiment, Conditional response is dog's salivation at the sound of bell or at the site of lab coats. The Conditioned response is triggered by the Conditioned stimulus alone in the after-Conditioning stage.



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Terms in Pavlov's the experiment: -

It is necessary to understand the following terms in order to understand Classical Conditioning. A Neutral Stimulus is one that evokes no response at first. The ringing of a bell was introduced by Pavlov as a neutral stimulus. A stimulus that causes an instinctive response is known as an

Unconditioned Stimulus. The food was the Unconditional Stimulus in Pavlov's experiment. An instinctive response to a stimulus is known as an Unconditioned Response. In Pavlov's experiment, the Unconditioned Reaction is the dogs drooling for food. A conditioned stimulus is one that can elicit a Conditioned Response in the future.The Conditioned Stimulus in this experiment was the ringing of the bell(after pairing with food multiple times), and the Conditioned Response was salivation at the sound of bell.

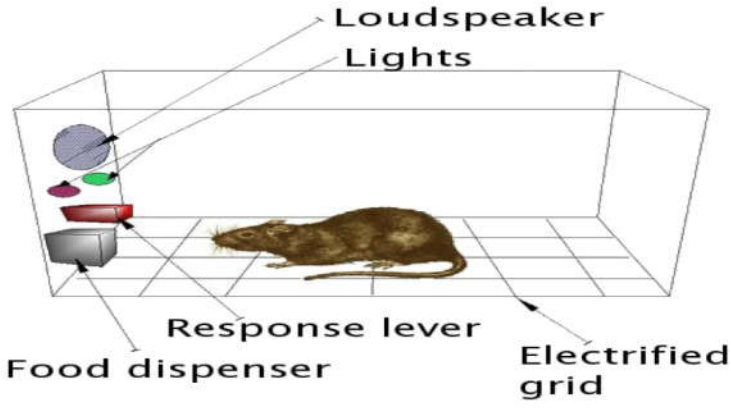
It is worth noting that the neutral stimulus transforms into the Conditioned Stimulus. It is also vital to remember that the Unconditioned and Conditioned Responses are identical save for the stimulus that elicits them. The response in this case was salivation, however the Unconditioned Response was caused by food, but the Conditioned Response was activated by the bell signalling the arrival of food.

1.3 LEARNING THROUGH OPERANT CONDITIONING

B.F. Skinner, a behavioural psychologist, was the first to describe operant conditioning. Skinner argued that classical conditioning could not account for all types of learning and was more interested in studying how consequences of actions influence behaviour.

Operant conditioning, like classical conditioning, is based on the formation of associations. However, through operant conditioning, associations are formed between an action and its consequences. When an action produces a desired result, it is more probable that the activity will be repeated in the future. However, if the behaviour results in a negative outcome, the behaviour becomes less likely to occur in future.

For example, when lab rats press the lever after the green light comes on, they will receive a food pellet as a reward. When they pressed the lever following the red light, they received a slight electric shock. As a result, the rats learn to press the lever when the light is green and avoid the red light.



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But Operant Conditioning doesn't just take place in experimental settings while training lab animals. It also plays an important role in everyday learning. Reinforcement and punishment always take place in natural settings, as well as in more structured settings like classrooms or therapy sessions.

1.3.1 The Basic Principle of Operant Conditioning is:

- The actions that are reinforced are stronger and are more likely to occur again in the future. If you tell a joke in class and everyone laughs, you're more likely to joke in a class again. Reinforcement is any consequence of a behaviour that is a desired outcome for the doer.

- The actions that result in punishment or negative consequences will be lessened, and they will be less likely to occur in the future. If you tell the same joke to a different class and no one laughs, you will be less likely to tell it again in the future. If your teacher scolds you for shouting an answer in class, you may be less inclined to disrupt the class again.

1.4 TYPES OF BEHAVIOURS :

a. Respondent behaviour - Pulling your hand away from a hot fire or jerking your leg when the doctor taps on your knee are examples of automatic and reflexive actions. You are not required to learn these habits. They just happen on their own, unintentionally.

b. Operant behaviour - These behaviours are under our conscious control, on the other hand. Some may happen accidentally, while others are planned, but the consequences of these actions determine whether or not they happen again in the future. The effects of our activities on the environment, as well as the consequences of those acts, are a crucial element of the learning process.

1.4.1 Reinforcements in operant conditioning

Any occurrence that strengthens or increases the behaviour it follows is referred to as reinforcement. Reinforcers are divided into two categories. The behaviour increases in each of these circumstances of a reinforcement.

a. Positive reinforcement: These are positive events or outcomes that occur as a result of the behaviour. A response or behaviour is strengthened by the addition of praise or a direct reward in positive reinforcement situations. If you work hard and your boss rewards you with a bonus, this is a positive reinforcement.

b. Negative reinforcement: This involves the elimination of unpleasant occurrences or consequences after the exhibition of a behaviour. The removal of something perceived as unpleasant strengthens a response in these cases. For example, If you are doing homework so that your

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teacher does not scold you, your behaviour is being negatively reinforced. Behaviour of doing homework is letting you remove unpleasant consequence if teacher scolding.

Punishments in the operant conditioning

Punishment is the occurrence of a negative event or outcome that leads to a reduction in the behaviour that follows. There are two types of punishments available. The behaviour decreases in both of these situations.

a. Positive Punishments - When an undesirable event or outcome is presented order to weaken the response. For example, scolding for misbehaving.

b. Negative Punishments- When a desirable event or outcome is withdrawn after a behaviour happens, this is known as punishment by removal. For example, taking away a child's video game after disobedience.

1.4.2 Reinforcement schedule:

It is important to keep in mind that when using reinforcement for modifying the behaviour, scheduling the reinforcements plays a significant role to have a great impact in the behavioural changes.

1.4.3 Different types of Schedules:

a. Continuous reinforcement - It means delivering the reinforcement immediately, every time a response occurs.

b. Fixed- Ratio Schedule-involves delivering reinforcement after a certain number of responses. For example- after every 5th time when the same response occurs, it will get the reinforcement.

c. Fixed- Interval Schedule - involves delivering reinforcement after a certain amount of time period. For example, reinforcement every 2 hours or in every 15 days.

d. Variable - ratio schedule - It involved delivering reinforcements randomly, after the responses without having a fixed number of time of the response needs to occur. For example, first reinforcement may be given after 3 trials and second after any random number of trails such as 6 trails.

e. Variable - Interval schedule - It involved the deliverance of the reinforcement randomly / without following the fixed time to reinforce after the response occurs. For example, first reinforcement is delivered at a random time such as after 15 minutes and second after 45 minutes, third after 10 minutes, etc.

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1.5 LEARNING THROUGH THE OBSERVATION

Albert Bandura believed that not all the types of learnings happen through the association or reinforcements but some also happen by observation.

He suggested that quite a bit of learning happens through perception and observation. Kids notice the activities of everyone around them, especially guardians and kin, and afterward copy these practices. In his notable Bobo doll experiment, Bandura uncovered how effectively youngsters could be directed to mirror even adverse activities. Kids who watched a video of a grown-up thrashing an enormous inflatable doll were then substantially more likely to duplicate those equivalent activities whenever allowed an opportunity. On the other had, the group of kids that watched a grown-up play nicely with the doll, displayed same behaviour themselves.

Bandura noted that not all the learningare supposed to change the behaviour of an individual. Children learn new things everyday from the observation. Also, it will be used or appears when it's needed or there is any motivation for it.

Main differences between these 3 Learning theories.

Classical Conditioning	**Operant Conditioning**	**Observational learning**
Learning occurs by forming associations between naturally occurring stimuli and a previously neutral stimulus	Learning occurs when behaviours are followed by either reinforcement or punishment	Learning occurs through observation
The neutral stimulus must occur immediately before the naturally occurring one	The consequences must quickly follow the behavior	Observations can take place at any time
Focuses on automatic, naturally occurring behaviours	Focuseson voluntary behaviours	Focuses on the give-and-take interaction between social, cognitive, and environmental influences

1.6 LEARNING: ENCODING, STORAGE AND RETRIEVAL

Learning is the process of accumulating knowledge that can be recovered later to assist us in achieving our objectives if all goes well. As a result,

we'll look at the aspects that aid or hinder learning, the factors that can contribute to forgetting, or the inability to recall previously acquired information when needed. We will examine how well learned knowledge or information is retained or not, throughout time spans ranging from a few minutes to weeks, months, and years. This chapter focuses on how knowledge is stored in (i.e., learned) and retrieved (i.e., remembered) from long-term memory, as well as how information might be lost (forgotten) when it is needed.

There are the main stages that are involved in the process of learning and remembering (or forgetting) the information.

i. ENCODING
ii. STORAGE
iii. RETRIEVAL.

Encoding:

Encoding involves the initial experience, perceiving and learning the information. This simply means paying attention to the stimulus and understanding it.

There are mainly 3 types of encoding methods:

1. Visual (Picture)
2. Acoustic (Sound)
3. Semantic (Meaning)

For example, how do you remember a phone number that you looked up in the phone book? If you can see it, use visual coding, but if it repeats itself, it is acoustic (by sound) coding. Semantic encoding is encoding information by understanding its meaning.

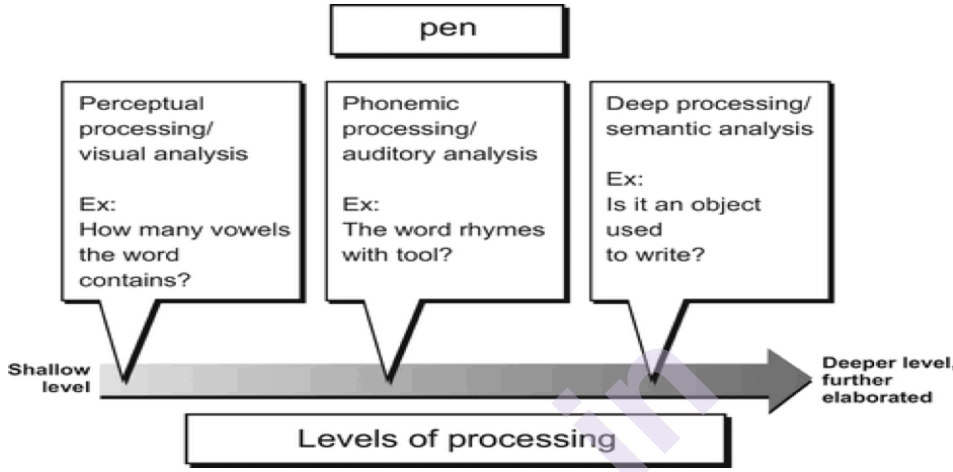
There is evidence that this is the most important coding system in short-term memory (STM) - the acoustic coding. When a person is presented with a list of numbers and letters, he tries to keep them in STM by studying them verbally.

The essay is a verbal process, regardless of whether the list of items is presented acoustically (someone reads it out loud) or visually (on a sheet of paper). The most important coding system in long-term memory (LTM) seems to be semantic coding (coding based on meaning of the stimulus). However, the iinformation in the LTM can also be optically and acoustically encoded.

1.7 LEVEL OF PROCESSING:

In their levels of processing hypothesis, Craik and Lockhart (1972) emphasized the importance of encoding. According to this theory, ‘surface' or ‘shallow' encoding of materials leads to poor retention, whereas ‘deep', more significant encoding leads to better retention and remembering. On this account, simple repetitious practise does not aid memory, but deeper, semantic processing does. Furthermore, according to

this viewpoint, learning does not have to be purposeful. Incidental learning, which occurs as a result of paying attention to the content in some way, can be powerful if the material is thoroughly processed. The Levels of Processing theory was put to the test early on (Craik & Tulving, 1975).



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Mnemonics*:*

There are various encoding strategies which help to enhance the memory.These strategies are called as mnemonics. These are used in various situations of our life. For example, when we prepare for the big speeches, or prepare to remember something without fail. There are different types of mnemonics:

a. Categorization is the key principle of the mnemonic. Grouped or clusters of the information to the familiar group would help more to encode and recall the information easily as compared to the words which are non-categorized. Many studies proved that categorization technique helps effectively by memorizing rather than non-categorization. For example, instead of remembering one's phone number as 20835397, one may form groups of 2 digits making it easier to remember such as 20 83 53 97.

b. Method of loci is another method in which mental imagery is used to enhance the recall of the information. For example-if you want to remember a list of items such as purse, tree, table etc. then first memorize a familiar road and important locations on that road. Now, lets say the first location is a shop. Now combine first item to be remembered with first location and form an interactive imagery. For example a shop selling purses, so on and so forth. When it is time to remember the items, you can just take mental walk through the road and locations will help you remember items as well. More weird the imagery, better the recall.

c. The Pegword method is similar to the method of loci, but here one uses a sequence of highly imaginable nouns linked by rhymes to the number sequence. standard example is 'One is a bun, two is a shoe, three is a tree, four is a door, five is a hive, six is sticks, seven is heaven, eight is a gate, nine is wine and ten is a hen.' To recall up to 10 items in sequence, using the pegword method, you would image the first item interacting with a bun, the second interacting with a shoe, and so on.

1.8 ENCODING SPECIFICITY:

encoding specificity principle states that recall is better if the retrieval context is similar to the encoding context (Brown &Craik, 2000; Nairne, 2005; Tulving& Rosenbaum, 2006). For example, assume that you are in the garden and you go to your room to get something ;but once you arrive in your the room, you have no idea why you are there, and once you go back to the garden, you will remember what exactly you wanted from the room. This example shows that, to have a better recall, individuals are supposed maintain same context for encoding and retrieval.

Storage

This has to do with the nature of memory, that is where the information is stored, how long the memory lasts (duration), how much information can be stored at any time (capacity), and the type of information stored.Store information affects how we retrieve it. There has been a large amount of research on the difference between short-term memory (STM) and long-term memory (LTM) with this regard.

Miller has given a magical number of 7+/-2 storage capacity of STM. However, Miller did not specify how much information can be stored in each location.This is because if we can "chunk" information together, we can store more information in our short-term memory. Information can only be stored for a short time in the STM (0-30 seconds). On the other hand, the capacity of long-term memory (LTM) is considered unlimited and it lasts for a lifetime.

Retrieval

Recalling the encoded information is called a retrieval. If we can't remember something, it is probably because we can't get it back. When asked to retrieve something from memory, the difference between STM and LTM becomes very clear. STM is stored and retrieved sequentially. For example, if a group of participants were given a list of words to remember and then asked to recall the fourth word on the list, the participants would go through the list in the order they heard it to retrieve information.

LTM is stored and retrieved by the link or cue. That's why you can remember what you think if you go back to the room where you first thought about it. It stores organizational information that may be useful for research. You can arrange information in sequence (for example, alphabetically, by size, or by time). Imagine a patient discharged from the

hospital whose treatment involves taking different medications at different times, changing dressings, and exercising. If the doctor gives these instructions in the order they should be taken during the day (i.e., in chronological order), it helps the patient to remember them. Some of the important phenomenon's with respect to LTM include:

Context effect: it was provided by Godden and Baddeley's (1975) study of scuba divers who learned lists either under water or on dry land and were then tested either 20 feet underwater or on land. It was found that lists learned under water were better recalled under water than on land and lists learned on dry land were better recalled on land than under water. Overall, recall in the same context as study was some 50 per cent better.

State dependent memory effects: It occurs if memory is better when internal physiological conditions at learning are reinstated at testing.

Mood dependent memory: It means that memory is better when the mood at learning is reinstated at the time of remembering the learned information.

1.9 SUMMARY

Learning is defined as a relatively permanent change in behaviour. As individuals, we are learning almost everywhere; as we observe and attend to a given information or even our surroundings. learning will take place as we observe, identify and eventually exercise what we attend to, putting things into action and if all those actions become habits one can say that they have learned something new.

Learning is also linked to memory, since whatever an individual observes in the process of encoding and retrieving is the information in order to put forththe learned information in to action.

The process of learning might vary from person to person and also depending on the context, which we can understand through the learning theories such as

a) Classical conditioning which focuses on learning that occurs based on conditioning that takes place with a given construct, or simply put learning from paired association.

b) Operant conditioning also known as instrumental conditioning, which explains how an individual learns with the help of reinforcements either positive or negative,

c) Social learning, a theory given by popular social psychologist Albert Bandura; aims to explain how an individual's environment can bring change in the behaviour which is primarily due to learning that Bandura termed as vicarious learning.

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Memory is an integral part of learning process that occurs through a threestep process of encoding, storage and retrieval. Encoding is paying attention to and understanding the material to be learned, storage is retaining the material and retrieval is remembering it from storage whenever needed. Learning will not happen if any of these stages is disrupted.

Another influential theory of memory which also explains learning is levels of processing. According to this theory information can be processed at either shallow, phonemic or semantic level and deeper the level of encoding better the recall.

1.10 QUESTIONS

1. Explain in detail theories of learning.
2. What are levels of processing?
3. Explain the process of encoding, storage and retrieval
4. Describe reinforcement along with types of schedules
5. What are Mnemonics and its types?
6. What is learning through observation?

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2

LEARNING, FORGETTING AND IMAGERY- II

Unit Structure

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2.0 OBJECTIVES

- To understand the concept of forgetting
- To understand the functional approaches to forgetting
- To understand the concept of everyday/real world memory
- To understand the concepts of Imagery

2.1 FORGETTING

Forgetting refers to failure to retrieve or recall the information which was available from the memory.

- **Interference**: According to interference theory, forgetting is the result of different memories interfering with one another. The more similar two or more events are to one another;the more likely interference will occur. For example, if you are trying to recall answer to an answer in the exam but instead answer to another question is coming to your mind, it is forgetting through interference.

- **Decay:** According to memory tracing theory, physical and chemical changes in the brain cause memory track to decay or weather away. Information in short-term memory lasts for a few seconds, and if it is not repeated, the traces of neurochemical memory quickly fade. Trace theory proposes that the time between memory and recall of this information determines whether the information will be retained or forgotten. If the time interval is short, more information will be recalled. If a long time passes, a lot of information will be forgotten and memory will fade.

- **The retrieval failure theory:** According to this theory, the main cause behind forgetting the information is, it never made the information into a long-term memory properly.

- **The cue dependent theory of forgetting:** Sometimes the information is actually present in memory, but it cannot be recalled unless some recovery hint is given. These hints are items present at the time the actual memory is encrypted. For example, all of a sudden if you pass through any particular smell of food, it takes you back to your childhood memories related to that day. The smell is the memory cue here.

2.1.1 Functional approaches to Forgetting:

Though forgetting seemed like a negative word, there are some incidents or memories where the individual would never want to recall it.

1. Retrieval - Induced Forgetting (RIF): The RIF model was developed by Anderson et al. (1994; Anderson, 2005) and addressed the forgetting of memories that appear to be caused by the retrieval of related memories. For example, if you focus on retrieving memories of what went well during the holiday, it may reduce your memory of unpleasant things that happened.

2. Directed Forgetting: In the DF model, participants were instructed to forget some things but remember others. A concrete example is provided by short-term chefs who must try to forget previous orders and keep only the current order until it is replaced by the next order (Bjork, 1970)

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3. Think/No-Think (TNT): The TNT model is a relatively new type of task that reflects situations where a person does not want to regain a memory in the face of a strong signal for that memory. For example, if you get into an auto accident at a traffic light on your way to work or school, you may not want to remember that event every time you pass those lights. To date, it has been explored using verbal materials rather than real-life traumatic stimuli.

2.2 EVERYDAY/ REAL WORLD MEMORY

Everyday memory refers to the memory activities that frequently occur in a person's everyday environment. Examples of everyday memory include remembering names, remembering the plan for the day, remembering groceries, remembering the amount of medicine you take, remembering phone numbers, directions, route to your workplace or other recent events of interest. Thus, the distinguishing feature of everyday memory and related research is that it involves the performance of tasks that take place in a natural way in the real world. This is in contrast to conventional memory lab tasks, in which individuals may be asked to do things that are unlike what they would in the real world, such as memorizing lists of words.

It is important to realize that everyday memory studies can take place both in the laboratory and outside the laboratory. In laboratory studies, individuals were asked to perform memory tasks that they might perform on a daily basis in the real world, such as sifting through shopping lists, remembering phone numbers. or memorize information from a news program. In field studies, individuals are monitored throughout their day and their memory function on specific daily tasks is recorded. For example, one can measure how accurately an individual takes medication over a period of time, using microelectronic displays for remote behavioural monitoring. The advantage of laboratory studies on everyday memory is that the experimenter has very precise control over the conditions under which memory occurs and can accurately standardize the material to be memorized from one individual to another. Such studies are also closer to the real life and hence have greater external validity. The downside of these studies is that the lab environment may not reflect all the variables that act on real-world individuals and affect their everyday memory. The advantage of fieldwork or naturalism is that one can study events that have real consequences for the individual participating in the study, but the disadvantage is that the researcher has little control over and knowledge of what is going on in the natural environment. Both types of studies will be discussed here.

Older adults tend to worry about some types of memory performance on a daily basis, but not others. For example, Reese et al. reported that older adults had little difficulty remembering important dates, but were more concerned about difficulty remembering names. These authors report that the elderly fear that a decline in daily memory functions may lead to a loss of independence. Therefore, the topic of daily memory function is of

interest to the elderly, and the focus of their concern seems to be on the daily functions with which they malfunction.

2.3 LABORATORY STUDIES

Laboratory studies often provide evidence of age-related decline in everyday memory processes. One of the most comprehensive studies was conducted by West et al. They found evidence of age-related decline in a series of daily memory lab tasks. The tasks involved asking subjects to remember names, locations of items, grocery lists, faces, phone numbers, and current events. In another study, Frieske and Park studied the memory of older and younger adults for news presented on radio, television, or in a newspaper. For all three formats, older adults remembered less information than younger adults, and both groups did better with television than the other two formats. Because television contains both visual and auditory information, these two sources of information appear to aid memory in young and old. These laboratory studies have forced the elderly to study unfamiliar subjects, and it is certain that learning new information, even if it is of an everyday kind, will be affected by age.

2.4 FIELD STUDIES

The picture of daily memory decline with age is quite different when we study memory in a natural context. In a series of studies, Park and his colleagues looked at how accurately older adults remembered when to take their medication, using microelectronic displays to record the date and time of taking the medication. Park and associates. (1992) reported that adults aged sixty to seventy made almost no medication errors over a one-month period, even though they were taking at least three different medications. In contrast, the older adults in the study, aged seventy-eight to ninety, made more mistakes, but were significantly helped by the introduction of memory and drug organizers. In a follow-up life expectancy study of thirty-five to seventy-five-year-olds who were taking blood pressure medication, Morrell et al. found that adults between the ages of sixty-five and seventy-five made the fewest medication errors of all ages and almost never forgot to take their blood pressure medication. They hypothesized that the reason for this high level of adherence was that older adults had sufficient cognitive resources to take the medication, and also had health beliefs and schedules compatible with taking the medication exactly.

In a follow-up study, a complex set of cognitive, psychosocial, and contextual variables were used to understand medication adherence in a sample of rheumatoid arthritis patients taking multiple medications (Park et al. 1999). These patients were given a large variety of cognitive tests and completed questionnaires about their health beliefs, lifestyle, stress levels, and self-perceived performance. These variables are used in structural equation models to predict adhesion. In this study, 47% of older adults (fifty-five to eighty-four) made no mistake in taking the medication over a one-month period, while the middle-aged participants had a significantly higher overall non-compliance rate. The best predictor of

non-compliance was reporting a busy and environmentally demanding lifestyle. Health beliefs, anxiety, and depression are not good predictors of compliance. Although age is not a predictor of non-compliance, people with low cognitive abilities of all ages are also more likely to become non-compliant.

We see the work on flash memory as a prime example of research rooted in a phenomenon of everyday life but using methods derived from laboratory studies.

2.5 FLASHBULB MEMORY

Flash memory is the vivid memory of a dramatic event and the circumstances under which that event was experienced or heard.

Flash memory is a type of autobiographical memory. Some researchers believe that there are reasons to distinguish flash memories from other types of autobiographical memories, as they are based on factors of personal importance, consequence, emotion, and surprise. Others believe that ordinary memories can also be accurate and lasting if they are very special, have personal meaning or are repeated.

Flash memory has six characteristics: location, current activity, informant, relevant influence, other influence, and consequence. Arguably, the main determinants of a flash memory are a high degree of surprise, a high degree of consequence, and perhaps emotional arousal.

The term flash memory was coined by Brown and Kulik in 1977.They formulated the Special Mechanism Hypothesis, which argues for the existence of a particular biological memory mechanism, when activated by an event beyond the degree of surprise and significant consequences, creates a detailed and circumstantial record of the experience. Brown and Kulik believe that although flash memories are permanent, they are not always accessible from long-term memory. The flash memory mechanism hypothesis specifically argues that flash memories have distinctive characteristics that are different from those produced by "ordinary" memorization. The representations produced by the special mechanism are detailed, precise, vivid and resistant to oblivion. Most of the early properties of flash memory have been debated since Brown and Kulik first coined the term. Over the years, four flash memory models have emerged to explain the phenomenon: the photographic model, the full model, the emotional integration model, and the importance-oriented model. Additional studies were performed to test the validity of these models.

Most people feel they have exceptionally detailed and vivid memories of the circumstances in which they first learned of dramatic and significant events such as the World Trade Center attack, attack on September 11, 2001, attacks on the London transport system on 7 July 2005, Princess Diana's death on August 31, 1997 and, for older readers, the assassination of John F. Kennedy on November 23, 1963. Brown and Kulik (1977) examined the memories for Kennedy assassination and called these memories flash memories. They proposed that dramatic and surprising

events important to the individual caused the activation of a special memorization mechanism and recorded as permanent information about the event and surrounding contextual information around factors such as who provided the information, where news was learned and what the individual did after hearing the news.

Weaver (1993) examined the time progression of normal memories (of meeting friends or roommates) and flash memories (of when President Bush first announced the start of the War, the first Gulf War on television) for a total of one year. The memory is brought up three times: within two days, after three months and after 12 months. Weaver found that accuracy, as indicated by consistency, decreased quite markedly after three months, but then stabilized, for both flash and non-flash memories. Both types of memories are exactly the same (matching the original memos). The main difference that emerged was that the participants were more confident in flash memory, but this did not translate to increased accuracy.

In general, it seems that flash memory is susceptible to the same types of forgetting and distortion as normal memory. The benefit of memories of flash bulb events may be due to their specificity that helps to reduce noise from similar memories (Cbelli & della Sala, 2008) and repetition effects (Bonhannon, 1988)

2.6 EYEWITNESSES' TESTIMONY

An important real-life area where memory is placed with considerable confidence is the legal system, where witnesses are asked what they remember about the events surrounding a crime. The law tends toward the conventional idea that memory is like a videotape that a witness can play back and relate to with precision. The juries were certainly influenced by the confidence that witnesses seemed to have and by the volume of details reported. However, several factors suggest that witness testimony should be treated with caution. Some witnesses may not have seen many of the events they were asked to report. For example, if you're walking down the street and a man quickly steps out of the bank as you pass, jumps into a waiting car, and gets kicked out, you may not be there at the time at that point. But then you'll be asked to give a detailed report on the man's height, hair color, clothing and outfit, color and license plate number, as it turns out you witnessed a bank robbery. Witnesses inside the bank may realize that a burglary is happening, but their memories may be affected by stress and anxiety. Indeed, Deffenbacher et al. (2004) in a meta-analytical review found a clearly variable impact of stress and anxiety on recall of faces and details at crime scenes compared with anxiety and low stress. In addition, if the crime involved a weapon, witnesses focused their attention on it and would be unable to report details unrelated to the weapon (Tollestrup et al., 1994).

From these and related studies, such as Elizabeth Loftus's study of implanting false autobiographical memories, it seems likely that post-event questions and clues can alter memories of the event. These effects can be considered as examples of retroactive interference, where later

information alters and distorts the memory of previously learned material. These results are consistent with the idea that memory can change and regenerate instead of being fixed and simply reproduce what was originally perceived, as Bartlett (1932), Neisser (1967) and others suggested a long time ago.

2.7 IMAGERY AND CONCEPTS

When we think of a concept, such as "cat," most of us experience a visual image of a cat, which can be enhanced by visual meows or auditory meows. Visuals convey information about the appearance of an object, and images associated with a concept can seem to be important in using that concept. To what extent do these images convey useful information and how do we use them? Image related concepts would be expected to be important for views representing knowledge, such as those proposed by Barsalou. Barsalou's conceptual simulation view proposes that knowledge of concepts is based on reconstructing previous experiences with members of the category. For example, experience sitting in a chair. These reconstructions or simulations can often be reported as images. Images partially reproduce the actual experience, but can generally be distinguished as less vivid and under human control than the actual perceptual experience. It should be noted that there are rare medical conditions such as Charles Bonnet syndrome, in which people have extremely vivid but uncontrollable hallucinatory images that are visually indistinguishable from world perception.(Plummer et al., 2007; Santhouseetal., 2000).

Although images can be found in all sensory domains, most imaging studies focus on visual imagery because for most of us, vision is the dominant channel of perception. and so we'll focus on visuals. Images can be viewed as representing the appearance of objects, and such knowledge of what members of general categories look like is an important part of conceptual knowledge. We will now look at the image results, including: the relationship between image and perception, image digitization, mental rotation, image ambiguity and neuroscientific approaches to imaging.

2.7.1 Imagery and Visuo- Spatial Process

We begin by asking to what extent the imagination of an object uses the same processes as real perception. With regard to visual images, this is often discussed in the literature regarding the degree of overlap between image and visual-spatial processing. We have all found that closing our eyes helps when trying to imagine an object. This everyday observation is consistent with the idea that the same mental machinery is involved in seeing as in imagining. Several experimental studies have reported an interference between visual tasks and simultaneous visual-spatial processing, supporting the idea that visual language and perception are based on the same mental and neural resources. These types of results were first reported by Brooks (1968) in a series of studies that have become classics in the field.

Brooks asked participants to think of a capital "F" and then asked them to imagine walking clockwise around the letter from a leading corner and indicating whether each corner was on top or bottom of the letter.

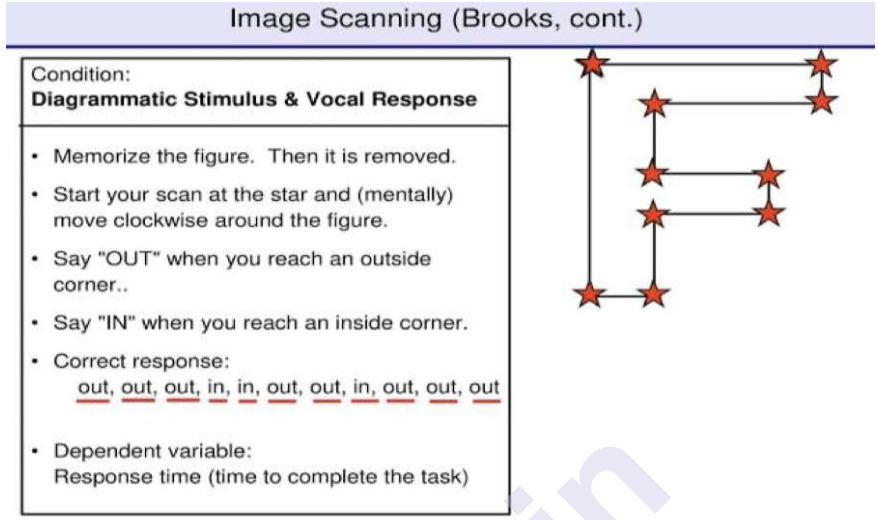

Figure 2.1 : Brook's imagery task

Image source: Google images

Brooks' imagery task.

When you go around figure F, do you find all the corners at the top or bottom, or not both? Starting at the lower left corner of the "F", the answers should be "yes, yes, yes, no, no, no, no, no, no, yes". Participants were asked to indicate their responses or mark a Y or N on a sheet of paper with a Y and N in irregular rows. A spatial response (pointing) has been found to slow performance compared to a verbal response. The reverse pattern was found when the main task was verbal, that is, remembering a phrase such as "a bird in the hand is out of the undergrowth" and indicating for each word whether it was a noun or not. These interference patterns coincide with the visual imaging task, which makes use of visual spatial resources.

A similar conclusion can be drawn from the study of Baddeley and Andrade (2000) on reported vividness of images when images are combined with a series of double scores or count aloud from 1 to 10 several times (a verbal task). Participants were also asked to rate the vividness of their images on a scale of 0-10, where 0 means "No image at all" and 10 means "Clear image and vivid as normal sight/hearing". For visualizations, the self-reported vibrancy of the images was reduced by typing, not by counting. When participants were tasked with creating an auditory image of familiar sounds, such as the ringing of a telephone, the vividness of the auditory image was reported to be reduced by counting but not typing. into the void. Regarding Baddeley and Hitch's working memory model, these

results indicate that the visual image uses the visual-spatial notebook portion of the working memory while the auditory image involves the tonal loop component. learning the position of working memory.

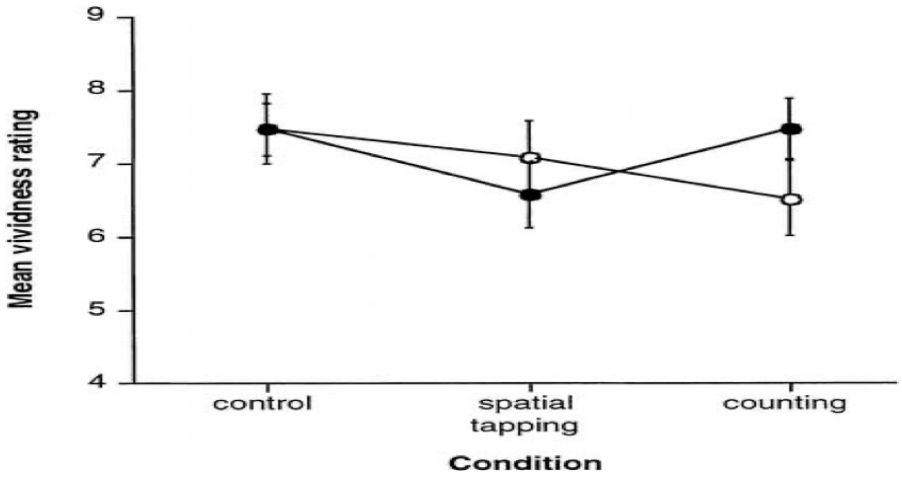

Figure 2.2: Baddeley and Andrade's (2000) result

Image source: Google images

2.7.2 Image Scanning and Comparing

Images are generally created for a practical purpose. For example, you may need to remove a large closet from a room. Will it be too wide to go through the door? With the help of pictures, you can try to compare the dimensions of the closet with the height and width of the door opening to "see" if the closet will fit. Or you may have purchased a complicated electrical device that requires multiple sockets to plug in. Are there enough outlets in your bedroom? The images can be used to try to scan an image of your bedroom to find and count electrical outlets. Several studies have examined such image scanning and comparison, focusing primarily on whether scanning and comparing images is like scanning and comparing actual visual stimulus.

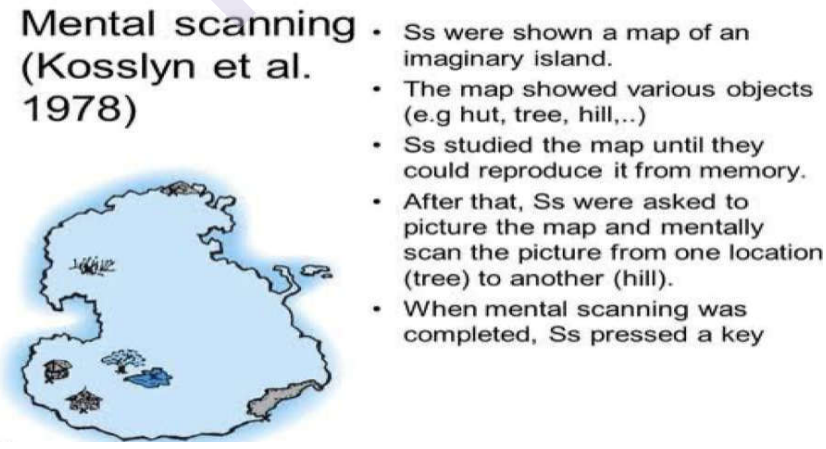

Figure 2,3: Map for the scanning task. Participants study the map before the scanning task

Image source: Google images

In a typical experiment, Kosslyn (1973) asked participants to study images of objects such as an airplane, a submarine, and a clock tower. The participants were then asked to take a picture of one of the objects and focus on a part such as the left or the top of the object in the image. Next, they were asked to look for a specific part such as the flag on the steeple and indicate when they found that part. The times to report the finding of the target part of the image varied according to the distance of the target from the starting point in the image. In this way, the spatially separated image parts were also separated in the image to a corresponding extent. These results support the idea that images are like pictures in the head.

Similar results were obtained from a map exploration study (Kosslyn et al., 1978). Participants first studied a map of a fictional island that contains seven landmarks. Participants first studied the map, then imagined the map and were asked to focus on one object and then scan the map image to find a second named object. The time to report that the second object was showed a very strong linear correlation (r = 0.97) with the physical distance between the objects on the map. These results, in turn, support the view that the images encode relative distances with some accuracy.

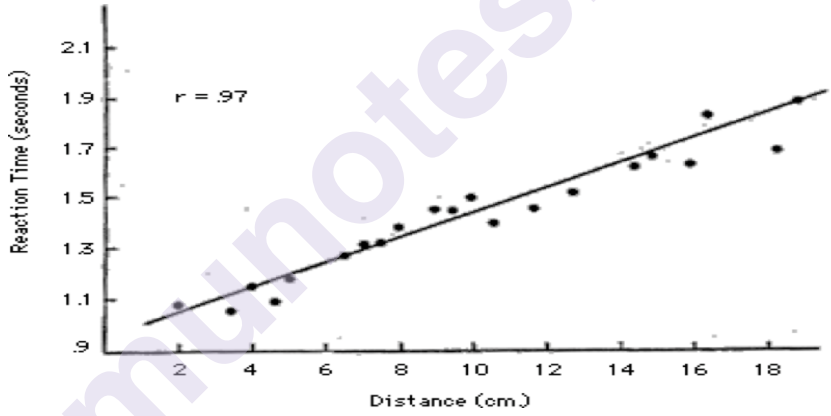

Figure 2.4: Scanning distance and reaction times

Image source: Google images

Other studies have asked people to compare images. For example, Finke (1989) asked participants "What is the largest pineapple or coconut?" And conclude that such comparisons are based on images. Moyer (1973) found that the faster such questions of size are answered, the greater the difference between real-life objects. Paivio (1975) also finds a similar pattern when real objects are presented. As a result, people quickly agreed that whales are bigger than cats, cats are bigger than toasters, suggesting that related images encode dimensions in a similar way to a painting. The basic finding that judgments about the difference between elements represented by symbols are easier to make for real objects that are very different in practice is known as the symbol distance effect. Again, studies of image comparison tasks have been done to support the idea that images are visual representations examined by the mind's eye just as images

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processed by the eye of the mind. Similar conclusions can be drawn from studies on the ability to mentally rotate the images of three-dimensional objects as described in the above image.

2.7.3 Critical view of imagery research and theory

Although the results of scanning, comparing, and rotating images are consistent with the idea that images function like images in the head, some researchers have challenged this viewand now we will discuss these assessments.

Pylyshyn (1981) suggested that the image scan results of Kosslyn et al. (1978) may reflect the participants' tacit beliefs or knowledge about what should happen in such tasks. Participants will tend to know that it takes longer to travel a longer distance and respond accordingly by inserting rest periods according to the distance involved.

Pylyshyn (1981) tested participants using island materials similar to those of Kosslyn et al. (1978). It replicates the original results when the analysis task is given. However, when participants were asked to tell in what direction one landmark was relative to another (northwest? Direct south?), the distance between the landmarks did not affect the weather. Therefore, if the digitization was explicitly requested, the participants produced results similar to the digitization results. However, if the task does not explicitly require a scan, the participant will not produce results that are consistent with the scanned image. A study by Peterson (1983) in which experimenters had different expectations about how scanning imaging experiments might work. In a mapping task based on Kosslyn et al. (1978) half of the testers were told that scanning an image of a map would be faster than scanning a real map, and half were told the opposite. The obtained results reflected the experimenter'sexpectations. When the perceptual scan needs to be faster, it's significantly faster than the 230-millisecond image scan. When the image scanning needed to be faster, the distance between the visual and perceptual condition was reduced to an insignificant 41 milliseconds (and the image speed increased by a significant 201 milliseconds compared to the condition with the opposite expectation). Presumably, expectations were subtly selected by the participants from the small unconscious cues given by the experimenters and influenced how the participants were responded.

Pylyshyn (1973) criticized the image metaphor for theoretical reasons. He points out that the image can be damaged arbitrarily (for example, cut in half or torn into many small pieces), but that the actual picture can only be transformed according to the important components added or remove. In addition, we may perceive real life images without prior warning of their content, but images must be purposefully constructed and based on our knowledge of the subjects being captured. Thus, two people may form an image of the same position in chess, but the professional player will "see" the offensive and defensive relationships in the image that the non-player or novice Beginners will not "see", because experts already have the necessary basic knowledge.

Pylyshyn (1973, 1981, 2002) has always argued for a modal propositional representations as the basis of visual experience and argued that visual experience has no real causal role in perceived visual experience, but rather is what is known as an "epigenetic phenomenon". A practical analogy is that the hum of a running washing machine is an epigenetic phenomenon, i.e. a by-product, of the machine's operation, but does not contribute to its operation. Likewise, Pylyshyn suggests that visual experience is a by-product of basic cognitive processes, but has no real functional role.

2.8 AMBIGUITY OF IMAGES

The famous Necker cube and the Duck Rabbit figure (Jastrow, 1899) are good examples of indistinct reversible shapes that often produce interlaced and even interlaced structures. In Necker's cube, perception alternates between a cube whose front face is on the right or left side, and in Duck Rabbit, perception alternates between a duck turned sideways and a rabbit turned sideways. Gestalt's cognitive theory proposes that ambiguous figures cause unstable representations to be resolved into alternative representations.

Figure 2.5: Jastrow's Duck-Rabbit Ambiguous (reversible)

Image source: Google images

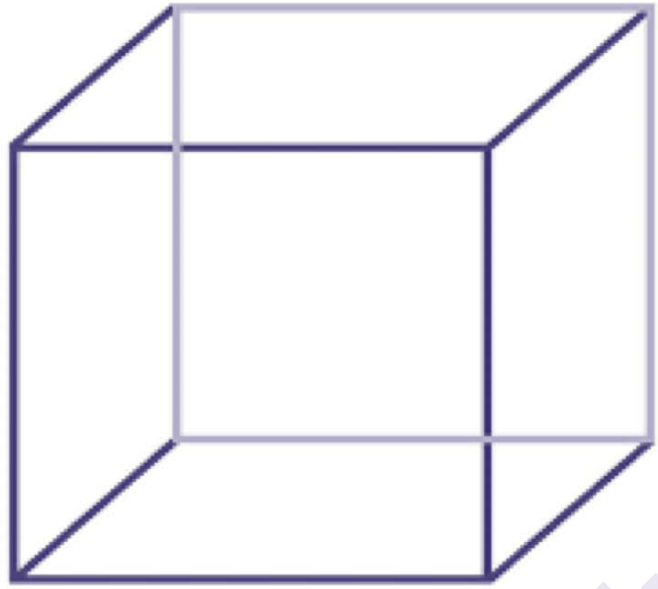

Figure 2.6: Necker cube: an ambiguous (reversible) figure

Image source: Google images

If the image is the same as the perception, then the image of characters such as the duck and rabbit should also be ambiguous and reversible. To investigate this possibility, Chambers and Reisberg (1985) showed their participants a line-drawing version of a duck rabbit for 5 seconds and asked them to visualize it for a later drawing task. All of the participants said they saw him as a duck or a rabbit (but not both). They were then shown other indistinct images and showed how these inversions changed the focus of attention. The participants were then asked to imagine the appearance of a duck and rabbit and find alternative explanations for their image. Finally, the children drew a picture of a rabbit and a duck and reported how they felt about the drawing. It was found that although the participants could easily reinterpret their drawings, that is, when they saw a rabbit, they had drawn turn into a duck and vice versa, they were unable to reverse the image. mental image of a duck (in a rabbit) or a rabbit (in a duck), which they built at the beginning of the experiment. This supports the idea that paintings are not exactly the same as objects but always have a fixed interpretation based on them. Similar results were reported later by Chambers and Reisberg (1992). In this second study, participants learned that a duck-and-rabbit figure was a duck or rabbit, and then mimicked that shape. After being tested with numbers comparing small differences from baseline, participants were told that duck characters were more sensitive to differences in the beak/ears of the image than to changes at the nose/back of the duck's head. The opposite pattern is that of a rabbit.

Chambers and Reisberg argue that in interpreting an image and shaping an organism, one is primarily concerned with the face, and for the interpretation of ducks the face is on the left (beak) and for rabbit's right face. Similar results showing difficulties in image reinterpretation were also reported by Pylyshyn (2002). However, under certain circumstances, when multiple clues and clues are provided, Mast and Kosslyn (2002) find a visual inversion with a stimulus of looking like a young woman in a certain way. direction and an old woman if turned 90 degrees outward. It seems that inverting the image is possible sometimes, but usually very difficult.

2.8.1 Neuropsychology /Neuroscience of imagery

If images are cognitive reconstructions, one would expect brain regions known to be involved in perception to also be involved in images. Several studies have examined this question. Roland and Friberg (1985) found significant activating effects in the occipital lobes (which are highly associated with visual perception), indexed by blood flow measurements, when participants performed the image exercise. Farah et al. (1988b) found similar results for visual images with a range of neuroscience measures, including event potentials. Zatorre et al. (1996) found similar effects with auditory imaging. The formation and use of the auditory image of the song has a secondary auditory cortex activation effect similar to, but weaker, the activation acquired by listening to the song.

In related studies, Kosslyn et al. (1995) asked participants to form images of different sizes and found not only increased occipital activation, but also specific occipital region activation depending on the size of the image being imaged. Fort. Ganis et al. (2004) compared the results of fMRI when people took pictures of the numbers and actually saw the numbers. This detailed comparison indicates that although similar brain regions are involved in perceptual and visual task versions, the regions most activated in imaging (occipital and temporal regions) are a reduced set of regions activated during perceptual imaging. This is consistent with the fact that people rarely confuse image with perception, with the exception of certain pathologies.

Overall, a large number of studies, reviewed by Kosslyn and Thompson (2003), often detect early involvement of the visual cortex in imaging tasks, especially when the images are detailed.

Although there is a wealth of neuroscientific evidence that images and cognition share brain mechanisms as suggested by the regenerative theory, several neuropsychological studies have found instances in which people with brain damage, visual perception is intact but vision is impaired. 'Pictures and others have images intact but lack visual perception. (Bartolomeo, 2002). These cases of double dissociation support the idea that although cognitive and visual brain regions overlap, they are not the same.

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2.9 SUMMARY

Unlike many other psychological constructs, forgetting as well remains a common phenomenon in our day-to-day life. It's so natural for individuals to often forget or experience the feeling where one fails to recall any information that is in fact, available with us.

Forgetting is caused due to many factors such:

Interference - different memories interfering with one another.

Decay- After a long time passes, a lot of information will be forgotten and memory will fade.

Failure to recall- As the information never really makes it to the long-term memory properly.

Even though there are factors that may cause an individual to forget certain information or memory, there are instances where individuals forget or try to forget purposely. Such as Retrieval - induced forgetting (RIF), Directed forgetting & Think/no-think (TNT).

Since, forgetting is also connected with memory one must also take into consideration the various methods to understand memory such as flashbulb memory I.e., a vivid memory of a dramatic experience. Eyewitness memory, is like an episodic memory mostly something that a person has witnessed.

Lastly, there are concepts which tend to be understood well with the help of imagery, isn't it easy to simply recall the shape or sound of an object that you read or thought of like we took an example of "CAT" and the Brooks Imagery task.

Forgetting, images and perceptions and the regions of the brains are connected with these tasks and experiments that we have discussed above.

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2.10 QUESTIONS

a. What are functional approaches to forgetting
b. Explain the terms "flashbulb" & "eyewitness" with reference to memory
c. What is the neuroscience behind imagery
d. What is the visuo-spatial process in imagery?
e. What are the factors due to which forgetting takes place?

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3

PROBLEM SOLVING - I

Unit Structure

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3.0 OBJECTIVES

- To understand the field of cognitive psychology and problem solving
- To understand the types of problem solving
- To understand the history & background of problem solving
- To understand in brief how creativity and thinking are related to problem solving.

3.1 INTRODUCTION

Broadly speaking psychology is concerned with both humans as well as animals with regard to their mind and behaviour. Specifically, the branch of cognitive psychology focuses on the cognition, that is the working of mind and how it represents with the information that we collect from our surroundings.

In our everyday life we collect a lot of information and use it very well. But some days are different such as when we encounter circumstances that are different than usual for example, when we misinterpret certain information or miscalculate some of our decisions. Various cognitive functions are used on a day-to-day basis for all of us from thinking, memory, perception etc. In this chapter we will focus on one of the cognitive processes called "problem solving".

Each one of us at some point in our daily life encounters some sort of problem. We all have confronted some problem, which is naturally not so easy to solve and also quite complex in nature. An individual might even think of a few solutions but the difficulty is to choose the most appropriate solutionthat not only solves the problem but also with less time or resources.

While studying cognitive psychology and problem solving, we are trying to answer questions such as what is the mental processing going on while an individual chooses to solve a problem in the first place, what are the options they are thinking about? How does an individual process the various solutions? What kind of mental tactics are used etc.

In our daily lives we face many problems which vary with the degree of difficulty. In case of some problems we may not think much and processing is also spontaneous and happens in a fraction of second for example, taking staircase if you just missed getting inside a lift or catching another train if you missed your usual one.But the same problems could be very severe if you have a leg injury. The amount of information processing will be more and you have to choose your options wisely.

Examining the area of problem solving helps us understand and answer the questions asked above. Perhaps, you must have noticed that problem solving is in a way thinking; whether it's about the actual problem or its solutions. Also, by answering the questions above we do not gain a complete explanation on the cognitive structure or process involved in actual problem solving.

Therefore, going forward we will understand thinking along with problem solving, nature of problem and types of problems and also look at the historical background.

Problem is a situation in which you have a goal but do not know how to achieve it.
Thinking is a process of mental exploration of possible actions and

Source: Gilhooly et al , 2014

Before we move on to exploring various types of problems, let us also see how creativity is linked to problem solving.

Creativity is a cognitive process that involves something novel or out of the box sort of perspective on a construct or in our case, we must say, on a

problem. The more the person is creative the more innovative the solutions can be.

3.2 CREATIVE PROCESS

There is a lack of a unanimous theoretical backup in the field of creativity. One of the reasons is the actual nature of the topic which makes it difficult to measure and has lead torelatively less attention from the research community. In spite of these gaps, creativity has recently become an important area of study when it comes to psychology and understanding the everyday applications of the same.

Wallas (1926) described the creative process as having four sequential stages:

a. **Preparation.** Formulating the problem and making initial attempts to solve it.
b. **Incubation.** Leaving the problem while considering other things.
c. **Illumination**. Achieving insight to the problem.
d. **Verification**. Testing and/or carrying out the solution.

3.2.1Creativity and functional fixedness

German psychologist Karl Duncker in 1945, described functional fixedness as a mental block when using an object in a new way that is required to solve a problem.

Functional fixedness is an obstacle to both creativity and problem-solving which sort of indicates how both the topics have a connection. When a person cannot think of an alternative way of using a product or item, functional fixedness not only hinders the problem-solving process but it also becomes a challenge for creative thinking pattern as it blocks the "out of the box" strategy.

Creativity is the ability to generate, create, or discover new ideas, solutions, and possibilities.
Functional fixedness is a mental block when using an object in a new way that is required to solve a problem.

3.3 PROBLEM AND PROBLEM TYPES

As discussed earlier, problem solving is, in a way thinking and in a general context we can conclude that thinking is free floating. Unless we are trying to look for some solutions to a problem or maybe when we are about to make some important decision. When we indulge in similar cognitive activities the process of thinking is more directed towards the end goal or solution.

One question that is in fact quite obvious for us to ask is what is a "problem" after all? Be it an animal or an individual who, when faced with something that clearly states the end goal but not the road to the goal can

be termed as a problem. Every problem in fact has a solution and also many options to choose from, not only that but problems can vary in the degree of difficulty, time period, and many other factors could be accountable in describing the nature and type of the problem.

3.3.1 Problem type's

We can categorize the problems in various sections based on some characteristics so one can group them together. Let's look at a few categories of problem, starting with well-defined and ill-defined problem which depends on how clear the problem is. Also, depending on whether a problem needs a specific understanding of the subject matter or not, than we can also categorizeit as knowledge-rich and knowledge-lean. Putting a problem under one roof of category based on various factors helps not only in getting a more in-depth understanding, but also helps further research on similar problems.

Well-defined problemis a problem in which starting conditions, actions available and goals are all completely specified.

Ill-defined problem is a problem in which starting conditions, or actions available or goals are not completely specified.

Knowledge-rich problemsare problems that require extensively specialized knowledge.

Knowledge-Lean problems are problems such as puzzles that do not require specialist knowledge.

With the help of above descriptions, we can see that problems that are well defined have a structure to them, the characteristics of such a problem includes the initial state or problem situation, rules/ strategies for solving the problem and also the goal state also known as the solution to a problem.For example, a mathematical problem such as "8-2" in which initial state (the problem statement and other information provided), steps to solve that problem (mathematical rules) are clearly defined. One also knows if correct solution has be obtained or not. On the other hand, if a professor asks you to come up with an exciting theme for college festival, as there are no defined steps to solve the problem, and even the initial state isn't objectively specified ("exciting' can have multiple interpretations),it is an example of ill defined problem.

Apart from the above-mentioned categories, problems can also be classified as advisory and non-advisory problems.

3.3.2 Adversary problem

When you are solving a problem from a game, let'ssay, chess, where you have an opponent whose goal is to stop or create barriers in the thinking process of the solver, you are facing an adversary problem. Games like poker, chess or bridge are classic examples of the adversary problem.

3.3.3 Non-Adversaryproblem

Unlike the adversary problem, in the case of non-adversary problem we do not have an opponent which can be called as rational thinker or even someone who thinks, the opponent here is immobile and is not making attempts to disturb or trouble the thinking of the solver. Some examples of advisory problems would be anagram puzzles or even some computer programs.

Non-adversary problems are problems in which the solver is dealing with inert problem materials with no rational opponent.

Adversary problems are problems in which the solver has to deal with a rational opponent such as in board games.

Source: Gilhooly et al., 2014

We further move to knowledge rich problems and knowledge lean problems. As the name goes any problem that requires more in depth understanding or specialized understanding of the procedures or rules is called as the knowledge rich problem. On the other hand, we have the knowledge lean problems which do not require the solver to have any specific knowledge of any procedure or subject any one can solve such problems. Some examples of knowledge rich problems could be medical diagnosis, legal decision making etc. Whereas, examples of knowledge lean problems include crossword puzzles, spot – the- difference pictures etc.

Lastly, we come to some problems that are based on the time- period which are known as large scale and small-scale problems. The ones that take longer periods to be achieved or completed such as building dams, or writing a book. On the other hand, whose tasks that take less time or efforts in solving such as, simple decision making like choosing the attire for an event will be termed as small-scale problems.

It is crucial that research is generated with respect to all of these various types of problem. However,research has taken place with few types like non-advisory, knowledge lean, small-scale problems, well defined problems. Let us see why these types are chosen over the others for research.

Non- advisory problems are good to start with since we do not have to get into the complexity of understanding and anticipating the opponents thinking and game plan.Knowledge lean problems or puzzles are the best since they do not need any specific understanding or degree of a particular area, which makes the population pool of the participants way more to choose from compared to a specific participate or sample pool. As most participants will be able to solve a knowledge lean puzzle the response increases giving the researcher an opportunity to generalize the findings.Well- defined problems just like the knowledge lean ones have more accessibility for majority of participants as the problem can be understood and interpreted well by most of the research participants.

Further, small- scale problems fit the criteria of a lab study or research as it requires much less time and it can be studied well with many participants who just have to spare a few minutes for the response.

3.4 BRIEF HISTORY AND BACKGROUD

Humans have been called as the rational animals; a species who has intellectual capability like no other. If we turn around and see our history, our evolution tells us how humans have been faced with numerous problems such as language, learning, differentiating between causes for an occurrence etc. Humans have also learnt to solve these problems with a verity of alternatives and solutions. Using the principals of deductive and inductive reasoning, insight and even trial and error methods.

Also, when we say humans are a species with intellect, meaning we can put to use the principles of thinking or creativity and logic depending upon the growth, exposure or simple the nature of the problem; the individual may use all or some combinations of these strategies.

Apart from humans, animals too indulge in many problem-solving strategies from finding food to protecting themselves.Animals use rule learning- a process of discovering logical rule from the available information or to gradually acquire the knowledge for sustaining in different kinds of circumstances. In past, we have seen in psychological experiments how animals use their problem-solving skills, some animals even go further in using complex problem-solving abilities.

3.4.1 Gestalt psychology

Gestalt is a German word which means “configuration” or something that’s brought together in such a way that it forms a whole picture or object.

Gestalt psychology is a school of thought that views behaviour, cognition or any worldly element as a whole. When we observe something, we do not look at components of a system or structure separately but we see it as a whole or complete object. For eg., when your friend comes in front of you and you look at their face, you do not perceive his nose, eyes, cheeks separately, instead you combine it together and recognize it as a whole - face of your friend. Therefore, Gestalt psychology is also known as “Holism” or defined as “The whole is greater than the sum of its parts”.

One of the founding members of Gestalt Psychology - Max Wertheimer, was on a train during his vacations when the movement of the train got him curious, upon which he explored the concept of perception. With this began the work of gestalt psychology in the early 20th century. Wertheimer did his experiments with stationary objects and showed howwhen same objects shown rapidly, they are perceived as moving - a phenomenon called as ‘optical illusion’ or what Wertheimer termed as “Phi Phenomenon”.

Along with Max Wertheimer, Wolfgang Köhler & Kurt Koffka are major contributors in the work & research in the field of gestalt psychology. Wolfgang Köhler's most popular experiment was with the apes about insight learning at Island of Tenerife on the Canary Islands.IN his experiment, Köhler hung some fruits up from the ground, and gave the four chimpanzees two sticks and three boxes to help them retrieve the fruits. After trying a few times the apes took some time to think and with a few trials they used the boxes to climb up and grab the fruit. They used a popular strategy for problem solving known as insight.

At the beginning of the chapter we discussed how animals use their problem-solving abilities when it comes to livelihood.The experiments done by Köhler explain how those apes could get a solution that came to them suddenly like it happens with insight learning and or with trial-and-error methods. The results of the experiments suggests that there is a correlation between the intellect and the development of the brain, which is quite similar with apes like humans.

Box 1.1 Wolfgang Köhler Experiment with Apes

Köhler had put a Chimpanzee named Sultan, in a cage along with two bamboo sticks.Some bananas were kept outside the cage but Sultan could not reach them as it is. The individual sticks too were not so long to help grab the fruit. The only way was to put together the sticks to reach the bananas. Sultan tried a few times but failed and accidentally joined the sticks together making a one long stick out of it which allowed him to get the bananas.

3.5 INFORMATION PROCCESSING APPROACH

Back in the mid 19th century, the information processing approach was highlighted once again and the reason behind the same was a new programme that was developed with computers.

These digital computers could be programmed to solve problems. We know that computers can solve calculations, or anything that is numerical, for example; employee data, financial stats etc. But coming from cognitive psychology perspectives, what is more interesting is that computers could also solve problems that do not involve numbers. Many chess players play against digital computers, and if not to perfection but some computer programs can identify or diagnose illness based on the symptoms that we enter. Computers can also do simple language translations.

The fact that computers use similar techniques to solve problems as humans is quite interesting and paves way for further study. Humans for example, use available information to identify the problem well, use older memories or information to get access to finding solutions and also use decision making techniques to choose a solution and apply the solution to the problem.If you compare, computers use similar principles when triggered with problem solving.

Let's take an example of anagram to understand how computers and humans solve problems.

Use the letters "**UDYTS**" to make a word. Let's try with using last two letters S and T and try to build a few letters and then see if it fits all the letters given in the anagram. We could solve this because we are familiar with the word **"STUDY"**.Thisshows that we use strategies such as use of long-term memory, retrieval of memory etc. When solving problems.In the same way, a computer will access the stored words, earlier used words from its programme memory to access information and find the correct answer, which in this case is "**STUDY**".

Programs that are similar to human thinking patterns are called as Simulation, which is different from a common method used by machines while mimicking the intelligence or thinking of human beings, popularly known as Artificial Intelligence.

Coming back to information processing in problem solving, lets discuss some key elements:

Problem space

Which can be defined as an abstract or commonly used graph and line format to represent the possible state of problem. This simply includes all the information that we know about the problem.

Problem space has two sub types: State- action space and Goal-subgoal space

State – action space

Which is a representation of changes of the problem in various states i.e.; initial state – intermediate state – goal state. Series of operations can be performed to transit from one state into another. This process is often pictured with the help of a tree diagram.

A very famous example that demonstrates this action space is the game of noughts and crosses (tic-tac-toe). Imagine that you are player one who has put X in one of the boxes. Your opponent has eight possible moves to make for each possible first move that you make. Once he plays, you now have multiple number of moves out of which one move can be played, so on and so forth.

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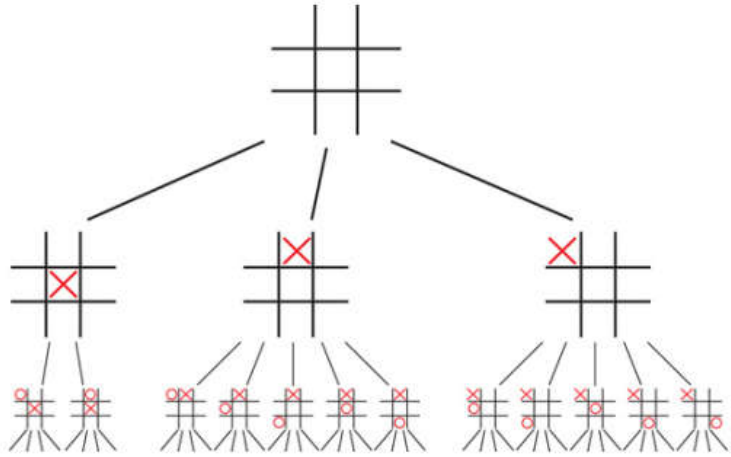

Figure 3.1: Sample tree diagram for noughts and cross problem. Image source: Gilhooly 2014

There are three methods by which state action tree can be searched systematically:

1. Depth first search: Considering only one move at a time. Although this is an easy method as it doesn't load heavily on memory, this method may not always guarantee attainment of goal

2. Breadth first search: This involves considering each possible move at each stage and adding it to the tree. This is an algorithm move that always guarantees attainment of goal.

3. Progressive deepening: This method is combination of first two methods. It considers only limited number of moves in depth, backs it up then searches for other alternative moves which are then stated in depth. This continues till all the branches have been searched in limited depth. If the goal is not attained then the depth level is deepened.

In a method known as 'hill climbing' intermediate states are also stated and problem solver works towards achieving them before achieving the final state.

Goal – subgoal space

Which is a representation that shows how problem goal can be broken into parts such as the sub goals and sub- subgoals. An everyday example of this would be, if I want to reach from my home in Kalyan to Vileparle, I can break it down into sub goals of taking rikshaw from my home to Kalyan station, then another sub goal of taking train to Dadar station, followed by final sub goal of taking train from Dadar to Vileparle, thereby achieving the final goal. The sub goals are often hierarchical where one step can be done only after a step before that is completed.

One of the very famous example of solving problem by using sub goals strategy is the problem of tower of Hanoi. The game consists of three pegs and a few disks of different sizes. All the disks are put randomly in left

most peg. The task is to move disks from left peg to right peg while making sure larger disk is never placed above a smaller disk. The problem can be solved following step by step procedure.

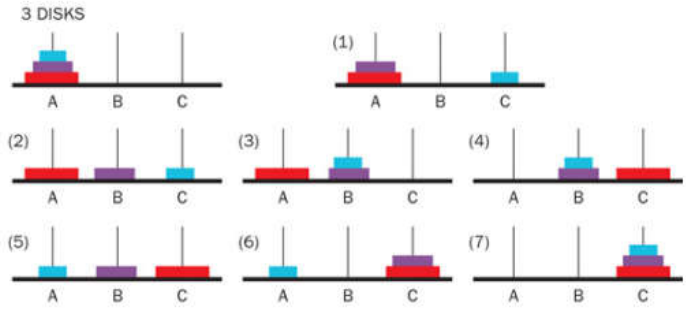

Figure 3.2 : Tower of Hanoi problem. Image source: Gilhooly et al., 2014

Information processing approach can be very helpful with well-defined problem and also those that can represent the search through problem spaces. Unfortunately, though, not all problems are well – defined and the initial formulation is not adequate to solve the problem. Thisiswhere the need for Insight comes in.

3.6 SUMMARY

- Problem solving is thinking oriented towards solving a specific problem that involves both the construction of answers and the choice of possible answers. We come across countless problems in our daily life that make us develop reaction, strategies, select possible responses, and test responses to solve a problem. For example, try to solve this problem: a dog has a 6-foot rope tied around his neck and a bowl of water is 3 feet away. How would the dog get to the pan? Solving this problem involves generating possible answers (of which there are few), choosing and testing them, and perhaps discovering the trick of the problem.

- Problems can be classified in different categories such as well-defined problems (those with clear initial state, goal and steps to achieve the goals), ill-definedproblems(those with unclear problem space, steps and goal), adversary problems (involving an opponent that tries to add obstacles in the process of problem solving) , non-adversary problems (no opponent involved), etc.

- Gestalt psychology and information processing approach are some of the important perspectives on problem solving. Gestalt Psychology advocates looking at the problem as a whole made up of interconnected parts instead of looking at parts separately. The strategy of insight problem solving comes from this perspective

- Information processing model compares human problem solver to a computer and draws parallels between human cognition and computer algorithm to solve problems.

- Problem space is defined as an abstract or commonly used graph and line format to represent the possible state of problem. It includes two important types: State action space and Goal-subgoal space
- State action space represents changes of the problem in various states i.e.; initial state – intermediate state – goal state. Series of operations can be performed to transit from one state into another.
- Goal - action pace represents how problem goal can be broken into parts such as the sub goals and sub- subgoals

3.7 QUESTIONS

1. Explain the phenomenon of functional fixedness with examples.
2. Describe in detail the information processing Approach
3. What is the role of Gestalt school in of thought in problem solving
4. Describe different types of problems

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4

PROBLEM SOLVING - II

Unit Structure

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4.0 OBJECTIVES

- To understand the role of insight in problem solving
- To understand the recent theories of insight
- To understand the various strategies in problem solving
- To understand the concept of creative problem solving

4.1 INSIGHT REVISITED

The information processing technique suggests solving problems by looking at the problem as it is which isbyeither utilizing state-action space search methods or goal-sub goal strategies. However, we have little understanding of how problems can be solved by looking at them in an alternative way ie., insight. However, there has recently been a development of interest in understanding insight difficulties, as first advocated by the Gestalt school

Non-insight problems can be solved within the initial representation; insight problems, on the other hand, necessitate a modification in the initial representation in order to be solved. Let us look at some insight problems:

- How would you arrange six matches to make four equilateral triangles?
- In one month, a man married 10 different women. All of the women are still alive and are still married. There was no violation of any anti-polygamy laws. How is it possible?

The initial representation in both of these cases needs to be rebuilt. In Problem 1, there is a strong temptation to work in two dimensions, but the answer necessitates the use of three dimensions to construct a little pyramid with one triangle at the base and three triangles on the sides. In Problem 2, the word “married” is commonly misinterpreted as 'got married to,' but it should be reinterpreted as 'causes to get married,' implying that the guy has the authority to perform marriage rituals.

4.1.1 Comparing Insight and Non-Insight

The subject of whether distinctions in processes between insight and Non insight problem solving can be established experimentally is a key focus of research. The Gestalt viewpoint holds that insight issue solving requires a specific 'restructuring' process, whereas some researchers argue that insight problem solving emerges through conventional search and problem analysis processes without the requirement for unique or uncommon processes.

Ratings on feelings, regarding how close the solver is to the solution and how confident they feel about solving the problem when they first hear it, are one way for addressing the question of whether distinctive processes are involved in insight tasks vs non-insight jobs. Metcalfe and Weibe

(1987) contrasted insight and non-insight tasks and discovered that the 'Feeling of Knowing One Could Solve' measured at the outset was a better predictor (correlation with solution = 0.4) for non-insight tasks than insight tasks (correlation = 0.08).

Below the figure shows the 'feeling of warmth' (i.e. how close one felt to solution) per 15 seconds during solving, which showed a consistent increase in feeling near solution with non-insight problems but no increase in warmth with insight tasks until the solution was reported. This finding backs with the notion of abrupt restructuring in insight tasks.

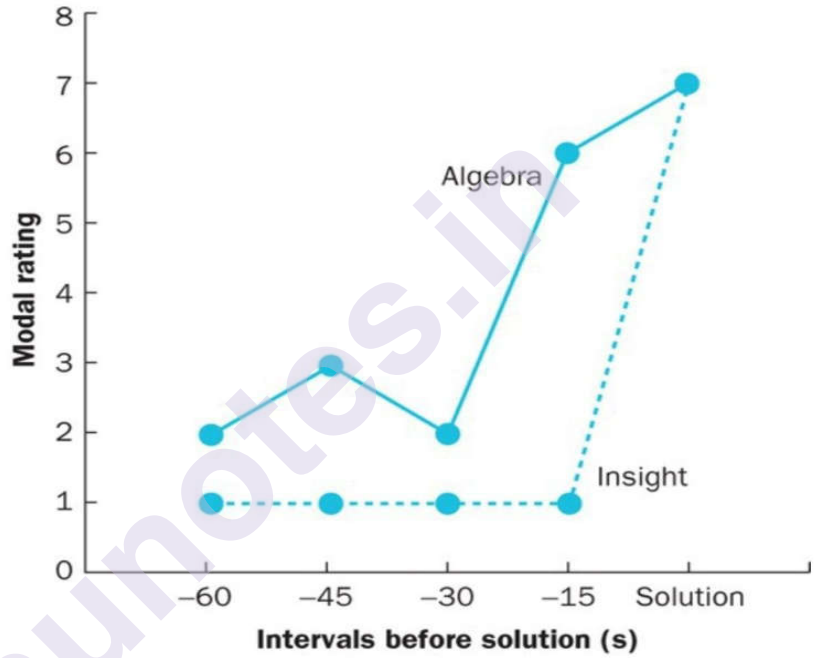

Figure 4.1 Ratings of warmth for insight vs. non-insight difficulties. For algebra, there is a continuous increase in 'warmth,' whereas for insight problems, there is a rapid jump in warmth shortly before the solution.

Image source: Gilhooly et al., 2014

4.1.2 Neuroscience Approach to Insight versus Non-Insight Tasks

In a 2004 study conducted by Jung-Beeman et al, researchers employed functional magnetic resonance imaging (fMRI) and electroencep halography (EEG) to see if there were any variations in brain activity patterns between insight and non-insight problem solving. A total of 124 Remote Associate Test (RAT) items were employed in the investigation. People must select a word that is an associate of three test words in this task, such as ' What term connects the words "boot," "summer," and "ground"?

To differentiate betweeninsight vs. non-insight solving, the researchers had participants self-report whether the solution came from insight or not

after each item. A self-reported insight solution was one in which participants had a "Aha!" moment and were confident that the solution was right. A methodical approach of trying out one association after another on each thing until an association that fit all three items was found could lead to non-insight solutions.

When insight solutions were compared to non-insight solutions, fMRI showed greater activity in one specific brain area, the right anterior superior temporal gyrus. Shortly before the solution, EEG recordings revealed a spike in activity in the same location. These findings show that different brain areas are involved in insight and non-insight solutions The findings are supported by a study which found that priming words given to the right hemisphere resulted in more insight solutions in RAT tasks than priming words received to the left.

4.1.3 Think Aloud Effects on Insight versus Non-Insight Problems

Another investigation into the differences between insight and non-insight problem solving looked into the probable effects of thinking aloud on insight and non-insight tasks. Schooler et al (1993) had participants do three insight issues and four non-insight tasks while thinking aloud or not. Thinking aloud lead to poorer performance on insight but not non-insight tasks, according to the findings. This was regarded as supporting the theory that insight tasks entail uniqueunconscious processes that are difficult to articulate. However, other researchers have failed to duplicate this finding, thereby calling into question its validity. Because the insight problems in the Schooler et al. study were mostly spatial, Gilhooly et al. pointed out that there was a confounding between insight tasks and spatial tasks in the Schooler et al. study, and that the apparent negative effect of thinking aloud on insight tasks was due to thinking aloud disturbs with spatial tasks. Because thinking aloud necessitates the re-coding of spatial thoughts into a verbal form for reporting, this interference occurs. Overall, the evidence for distinct unconscious mechanisms in insight solving from think aloud experiments is relatively modest.

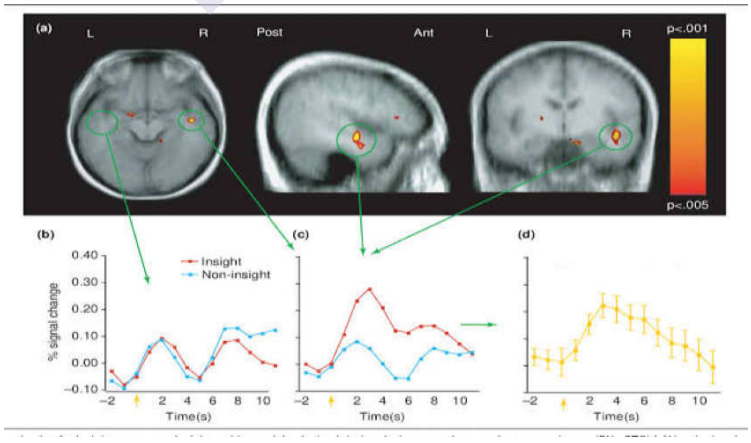

Figure 4.3: fMRI results for insight and non-insight problem solving.

Image source: Gilhooly et al., 2014

4.2 RECENT THEORIES OF INSIGHT

The empirical distinction between insight and non-insight problem solving appears to be well established based on the findings discussed above. However, the question of how to theoretically describe insight solving remains open. Recently, two major approaches have emerged: representational transformation and progress monitoring, sometimes known as "the criterion for satisfactory progress theory."

4.2.1 Representational change:

As previously stated, Gestalt accounts of insight processes like reorganisation were hazy. Researcher Ohlsson (1992) has given a more specific description of insight in information processing terms in his representational shift theory.

The following are the main stages and processes in representational change theory:

- *Perception of the issue:* The problem is encoded by a person.
- *Solving problems:* Initial representation-based heuristic search procedures. These procedures use long-term memory to retrieve possible actions or operators that modify the present state of the problem into new states.
- *Impasse*: When it comes to insight tasks, the initial representation is deceptive and prevents a solution. As a result, people are stuck in impasse when they have a blank mind and can't think of any more steps to try.
- *Restructuring:* Elaboration, re-encoding, or constraint relaxation are used to create a new encoding. Elaboration is the process of adding information to an initial representation by identifying elements that were previously overlooked. Instead of simply adding new features, re-encoding involves totally modifying the encoding. For example: In the problem of the marrying man, changing the understanding of the word "married" causes the problem to be re-encoded. Relaxing limits on what is necessary in the objective or what actions are permissible is referred to as constraint relaxation. In the nine-dot problem, removing the limitation to operate within the square shape is an example of this procedure. These reorganisation processes, according to Ohlsson, occur outside of consciousness and involve autonomic processes such as spreading activation.
- *A partial understanding:* Following restructuring, the retrieval of possible actions breaks the impasse and leads to a series of steps that lead to a solution.
- *Detailed information/Full insight:* Following restructuring, retrieval of feasible actions leads to a solution state or a condition close enough to

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the solution that the solution can be expected within a limited mental look-ahead.

Matchstick algebra problems were used to investigate the representational change theory. An inaccurate Roman numeral equation is presented in these exercises, and the participant's duty is to move one match to rectify the equation.

Figure 4.1: Problem with matchstick algebra. To make this equation correct, reposition one match.

Image source: Gilhooly et al., 2014

When we think of equations, we usually think of altering numerical values but not operators (+, =). These issues necessitate re-encoding, which entails breaking apart and rearranging groups of matches that form conceptual units or 'chunks.' More harder issues necessitate a relaxation of the limits on equation form.

Figure 4.2 Constraint relaxation is required in a matchstick algebra issue. To make this equation correct, reposition one match.

Image source: Gilhooly et al., 2014

Knoblich and his colleagues. discovered that re-encoding chunks in the first problem, such as changing VII to VI and II to III(correct answer for matchstick problem 1: (VI=III+III) by relocating one match, was easier than easing the constraint on the normal form of equations in the second problem, such as changing IV = IV + IV to IV = IV = IV.

Overall, the matchstick algebra problem solving experiments offered support to the representational change hypothesis, but further study is needed to evaluate how well the theory would expand to a wide range of other issue areas.

4.2.2 Progress Monitoring:

The 'progress monitoring hypothesis' created by MacGregor et al., (2001) is an alternative to representational change theory. Using incorrect heuristics, according to this theory, is the main source of difficulties in insight tasks. They advise that people track their progress against some criterion while they look for steps that will assist them attain a solution. Instead of impasses, failure to achieve a progress requirement causes

restructuring. The theory can be described using the nine-dot issue as an illustration of how they used their technique.

Traditional explanations for the nine-dot task's difficulty propose a fixation (set) on the square shape, excluding other possibilities. Instructions to search outside the square, on the other hand, were shown to be ineffective (Lung and Dominowski 1985) suggested other ineffective limitations, such as believing that all lines begin and end with dots.

A different explanation including two important points was proposed by the progress monitoring theory.

These are (1) the use of a maximisation heuristic, in which each move or decision is an attempt to make as much progress as possible toward the goal, and (2) the use of progress monitoring, in which the rate of progress is constantly assessed, and criterion failure occurs if it is deemed to be too slow and inefficient. A different tactic could then be pursued.

When applied to the nine-dot task, progress monitoring theory suggests that (1) the maximisation heuristic would be for each move to cover as many new dots as possible, and (2) progress monitoring would involve comparing the rate of progress to the number of dots required to be covered per line to solve, and criterion failure would occur if no move met the criterion. A different tactic could then be pursued (e.g. extending lines).

MacGregor et al. investigated the progress monitoring theory explanation of the nine-dot task by administering two versions of the problem, version A and version B, to participants.

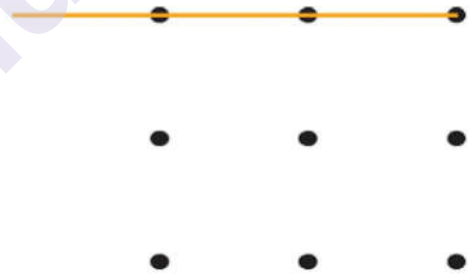

Figure 4.3: Nine-dot issue with a twist (version A). A variation of the nine-dot issue that includes a tip to think outside the box.Participants task is to connect all the dots using 4 straight lines and without lifting their hand

Image source: Gilhooly et al., 2014

If 'constraint relaxation' is all that's required to imagine 'beyond the box,' then participants should perform better on version A than B, because version A depicts a line that extends beyond the box. If criterion failure is required, participants will do better on version B because they will be able

to cover fewer dots in the next two steps, allowing them to see that they are on the wrong track sooner. According to MacGregor and colleagues , just 31% of those given version A were successful, whereas 53% of those given version B were correct.

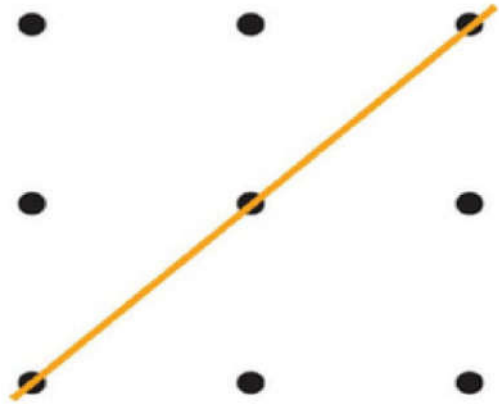

Figure 4.4.The nine-dot problem has been tweaked even more (version B). There's also a suggestion to use the diagonal.

Image source: Gilhooly et al., 2014

More experiments on progress monitoring theory employed coin manipulation issues like the eight-coin problem shown below, in which users must move only two coins so that each coin touches exactly three others.

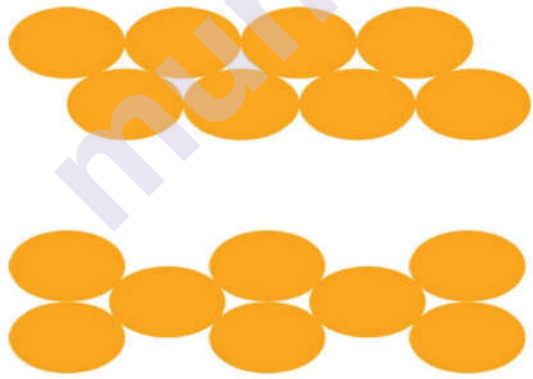

Figure 4.5: The eight-coin problem is presented in two different ways. Participants task is to only move two coins to ensure that each coin is in contact with at least three other others.

Image source: Gilhooly et al., 2014

If the approach is just to attain a short-term goal of getting one coin into touch with three others, then the upper form of the issue has 'no move available,' whereas the bottom version has 20 moves available. As a result, criterion failure will occur considerably sooner in the upper version,

resulting in more solutions. In the lower version, a lot of time and effort would be spent pursuing what appear to be possibly correct options that would finally fail to produce a solution. In the upper form, 92 percent solved the problem, compared to 67 percent in the lesser version, as predicted by the hypothesis. The answer of the problem shown in the below given figure.

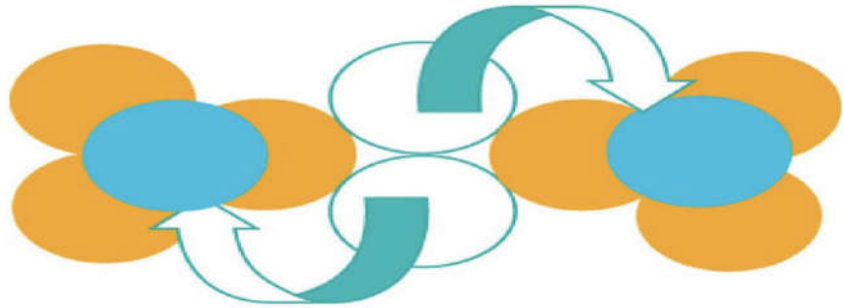

Figure 4.6:The answer to the eight-coin Problem

Image source: Gilhooly et al., 2014

Overall, the core argument of progress monitoring theory is that when constraint relaxation occurs after criterion failure, insight is most likely to emerge. The research mentioned above provides strong evidence for this. As a result, the theory does a good job of explaining why people change their strategies, but it's less clear how new strategies are really implemented.

4.3 KNOWLEDGE RICH (EXPERT) PROBLEM SOLVING:

Most intellectual clinicians indicate that it requires around ten years of extraordinary practice to acquire skill in a particular field, which has to be the primary interest area of the individual. One cannot expect to have expertise in other areas than the primary interest area. For example, if an individual’s primary interest is in singing, then he cannot expect him to expertise in designing or in dance.

Interestingly, experts' contrast from new learners during a few periods of problem solving. We'll start with a portion of the benefits that work in the beginning stages of problem solving, investigate contrasts in critical thinking systems, and lastly think about more broad capacities, like metacognition.

Beginners and specialists contrast considerably in their insight base, or constructions.A researcher found in her investigation ofcritical thinking in physical science that the learners just needed significant information about the standards of physical science. you need the suitable constructions to comprehend a theme appropriately. Specialists might perform particularly well in the event that they have had preparing in an assortment of important settings.

4.3.1 Knowledge base

The knowledge bases or schemas of novices and experts differ significantly. For example, In the mathematical problem solving, the novices simply lack important knowledge about mathematical principles. In order to properly understand a topic and solve problems, an individual must have the necessary schemas. Experts who have received training in a variety of relevant settings may perform especially well.

4.3.2 Memory base

Experts differ from novices in their ability to remember information related to their field of expertise. Expert's memory skills are often very specific. Expert chess players, for example, have a much better memory for various chess positions than novices. Chess experts, according to one estimate, can recall approximately 50,000 "chunks," or familiar arrangements of chess pieces. Surprisingly, chess experts are only marginally better than novices at remembering random chess piece arrangements. In other words, experts' memory is significantly better only when the chess arrangement fits into a specific schema. This better memory could be result of years of practice they have had in the field.

4.3.3 Problem Solving Strategy

Experts are more likely than novices to use the means ends heuristic effectively when confronted with a novel problem in their field. That is, they divide a problem into several subproblems or sub goals that must be solved in a specific order. The analogy approach is also used differently by experts and novices. Experts are more likely to emphasize structural similarity between problems when solving Physics problems. Surface similarities, on the other hand, are more likely to distract novices.

4.3.4 Speed and Aaccuracy

Experts, as one might expect, solve problems much faster and more precisely than novices. Their operations become more automatic, and a specific stimulus situation also prompts a response. Experts may be able to solve problems faster on some tasks because they use parallel processing rather than serial processing. Parallel processing deals with two or more items at the same time. Serial processing, on the other hand, only deals with one item at a time. One study discovered that experts frequently solved anagrams in less than 2 seconds. These experts typically solved the anagrams so quickly that they must have been considering several alternative solutions at the same time. The novices, on the other hand, solved the anagrams so slowly that they were most likely using serial processing.

4.3.5 Metacognition

Experts are better than novices at monitoring their problem solving. for example, they appear to be better at judging the difficulty of a problem and at allocating their time appropriately when solving problems.

Furthermore, when they realize they have made a mistake, they can recover relatively quickly. Experts are unquestionably more skilled at various stages of problem solving, as well as in monitoring their progress while working on a problem. Experts, on the other hand, perform poorly on one metacognitive task. That is, experts, in particular, underestimate the amount of time that novices will need to solve a problem in the expert's area of specialisation. In contrast, novices are more accurate in predicting that the problem will be difficult to solve.

4.4 CREATIVE PROBLEM SOLVING

Creative problem solving is a method for approaching a problem or a challenge in a novel way. The procedure aids in the redefining of issues and opportunities in order to generate fresh reactions and solutions.

4.4.1 What is a Creative Approach?

We say, it is about taking a creative approach to problem solving. What exactly does that imply? Simply said, an approach is how you approach, advance, or get closer to something. An approach is a method of bringing about change in the context of this book. There are at least two types of approaches to bringing about change: creative and non-creative techniques. A creative method means that you are striving to reach a novel, unstructured, and open-ended result. Frequently, these situations entail an unstructured problem with unclear solutions, popularly known as ill defined problems. Because there is no ready-made solution and you must use your knowledge and abilities to evaluate, a creative strategy encourages you to employ your imagination as well as your brains during your approach. It also necessitates a more comprehensive strategy that incorporates the complete system of people, technique, content, and context.

Taking a creative approach also entails having a brave mentality, which includes being open to new experiences, accepting ambiguity, and stepping into new and unexpected territory. Because creative techniques are about assisting you in moving from a location you are familiar to one that is different and maybe unknown, and the outcomes of your efforts are potentially unclear, this attitude is frequently required.

4.4.2 Divergent Production

Many current scholars also emphasizethat, rather than a single best answer, creativity necessitates varied thinking.

There are moderate relationships between people's creativity test scores and other judgments of their creativity, according to research on divergent production tests. The quantity of diverse ideas, on the other hand, may not be the best indicator of originality. After all, this criterion does not consider whether the answers fit the three criteria for creativity which is novelty, high quality, and utility.

4.4.3 Creative theory of Investment

Some experts proposed that those who work in the arena of ideas purchase low and sell high as well. That is, when no one else is interested in the "investment," they come up with a creative idea. They move on to a new creative undertaking later, once the idea has gained traction. The famous shark tank show has shown us several example of an entrepreneur coming up with least explored idea and making it a big hit

What are the characteristics of these intelligent and creative investors? The key elements of creativity, according to Sternberg and Lubart investment theory, are intelligence, knowledge, motivation, a supportive environment, a suitable thinking style, and an appropriate personality. You'll need all six of these qualities to work productively. Consider a person who meets five of the criteria but has a low intellect level. This person is unlikely to develop anything innovative.

It's worth noting that the investment approach to creativity also emphasizes issues outside the individual's control. Individuals may have creative qualities. However, they will not be creative in the workplace if they do not work in a supportive environment.

The investment hypothesis of creativity is interesting in and of itself, especially because it stresses the complex criteria for creative success. Let's look at one of the six requirements now: motivation. As you'll see, certain types of motivation are more likely to boost creativity than others.

4.4.4 Intrinsic Motivation-Based Creativity

People are more likely to be creative when they are working on a task that they truly enjoy, according to research. In one study, Ruscio and his co-authors gave college students a standardized test of intrinsic drive. The participants were asked to score their interest in three types of activities :writing, painting, and problem solving.

The students returned to the laboratory a few weeks later, where they were instructed to complete activities in these three categories.The pupils' innovative projects were then judged by a panel of experts. The findings revealed that students who scored high on the standardized exam for intrinsic motivation were more likely to develop a creative project.

4.4.5 Extrinsic motivation-based creativity

Many studies have shown that when students are working on projects for external causes, they create less creative output. People's extrinsic motivation is high when they see an activity as merely a way of receiving a reward, a good grade, or a positive appraisal. Since their intrinsic motivation is frequently diminished, as a result, their creativity is likely to decrease.

When college students were told that their poemswould be judged by a committee of professional poets, they generated fewer imaginative poetry, according to representative research. Other studies backup these conclusions. The same effect is frequently observed in both adults and children, as well as in both creative and verbal inventiveness.

For many years, scholars had held a straightforward viewpoint. intrinsic motivation is good, while external motivation is bad. You've undoubtedly spent enough time studying psychology to realize that no conclusion in our field can be that simple. According to a more extensive examination, creativity can really be boosted if extrinsic sources supply relevant information.

Extrinsic motivation, on the other hand, hinders creativity by controlling and limiting your possibilities. The ramifications of these discoveries for education and the workplace are significant: Encourage people to work on projects that they enjoy, and use an external compensation scheme that does not detract from their creative efforts.

To show what we mean when we say "creative methods to problem solving," consider the following examples.

- Actively developing a wide range of options and identifying the most intriguing ones to investigate further. Maintaining a cheerful mindset while being open to many various alternatives. Solving future-oriented issues that do not yet exist.

- Considering facts, impressions, feelings, and ideas from a variety of perspectives. Willingness to delve deeper into assumptions.

- Considering the topic or situation from a variety of perspectives. Being able to experiment with other options.

- Developing a large number of diverse and uncommon ideas with the ability to solve the problem or fulfil the challenge in a novel and beneficial way. Being able to come up with ideas and defer judgement as necessary. Possessing the ability to generate ideas.

- Putting time, effort, and talent into moulding, refining, and developing a wild or highly unconventional notion into a viable solution. Persistence is a virtue.

- Taking into account components of the situation surrounding the solution in order for others to agree with your solutions. Being aware of the situation and the individuals who may be affected by your solution, as well as attempting to gain support and approval.

4.5 SUMMARY

Often, we experience a sudden discovery of a solution to a problem which could have been a difficult task. Individuals tend to experience insights very suddenly without any preparation or even trying; which is why probably we also know insights as solutions coming from trial-and-error method.

Insights are those solutions that we experience spontaneously, and it occurs even more naturally as we face problems that we have also solved or been faced with in the past.

Insight vs non-Insight problem

As discussed above a problem that is designed in such a way that it promotes the "A-ha" feeling which makes you realize the solution, while you also learn to solve similar problems and the insights become more frequent due to the past experience. The Non- insight problem on the other hand, are those problems that are designed in such a way that one nay not experience insights since, to solve the on-insight problems one must use some well-defined methods, or look for solutions that come from some systematic process or knowledge.

We must also take into consideration the neural activity associated with insights, also factors such as type of problem, innovation or creativity in solving the problem and the role of intrinsic and extrinsic motivation in creatively solving the problem.

Experts differ from novices in problem solving in several ways such as they have vast knowledge base, better memory, better meta cognition, etc.

Creative problem-solving approach involves solving problems in novel and original way. It requires divergent thinking and is often inspired by intrinsic motivation. Extrinsic motivation may help problem solver not get discouraged or distract when solving problems.

4.6 QUESTIONS

1. What are insightful and non-insightful problems?
2. Explain the role of creativity in problem solving
3. What is creative theory of investment

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5

DECISION MAKING - I

Unit Structure

5.0 OBJECTIVES

- The chapter here explains what do we mean by decision-making and different phases of decision-making.
- Understanding different theoretical models of decision making
- To learn one of the oldest and most famous theory of decision making- Expected Utility Theory
- Understanding Prospect theory of Decision Making in relation to utility and subjective probability
- Understanding how the concept of probability is related to decision making and how it leads to judgments in decision making
- It explains the various heuristics that we use while making decisions

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5.1 INTRODUCTION

You are a final-year graduation student trying to find your way through life. The next task on your academic agenda is to find a suitable college from where you can pursue your Masters/Post Graduation. But there are so many colleges that one has to choose from and the decision you make will have an impact on your life. Now what cognitive processes you might put to use in this situation to evaluate your options? Cognitive psychologists use the term "decision making" to refer to the mental activities that take place in choosing among alternatives.

In day to day life we tend to face many situations where we have to take certain decisions ranging from the not very important, such as which clothes to wear today, to the moderately important, such as where to go on a vacation, to the very important, like what career to choose. We could say that decisions are a type of problem in which the alternatives are set out and the problem is to choose the best alternative available. This becomes easy, for example if the choice is between different amounts of money, most people would readily choose the larger amount. However, if the options are complicated and have uncertain consequences, for example deciding what career to choose or which job offer to take, the decision may be very difficult and have no clear correct solution. Typically, difficult decisions require a lot of thinking to figure out the possible results of different choices and so decision making is a complex cognitive activity.

5.1.1 What Is Decision Making?

In simpler words, decision making is a cognitive process of selecting a belief or a course of action among several possible alternative options. Out of the number of given available alternatives to us we then make a choice through judgment and reasoning. This choice which we make is according to our needs and requirements and this choice process is actually a very risky process. The reason being that once we make a choice, once a number of options are available to us and we make a choice there are always a chance that the choice will backfire, meaning which that if there are five different options or five different conclusions which can be drawn from a particular mental representation or five different interpretations of a particular mental representation.Choosing one representation over the other basically puts us into a situation where if the choice that we are making is wrong we could have a wrong decision and that could harm us in some or the other way.

So, decision making is a very complex process. In decision making we need to make choices under different situations. Another interesting thing that we should remember is that most of the times these choices have to be made in uncertainty or with a certain amount of risk. Considering the fact that human beings are not calculating machines and don't have all the information available for making a best choice out of the number of options which have been given to us. So, we tend to make these selections which come out of judgment, through a process or through a state of

uncertainty, in a state of risk and so, we tend to minimize this risk or make decisions which do not backfire on us.

We know that decisions are frequently made under uncertain conditions, some do not produce the desired results, even when made carefully and after thorough, unbiased consideration of the evidence. Psychologists generally argue that the "goodness" of decision making cannot be measured by the success of individual decisions—for example, luck frequently plays an undue role. Instead, the rationality of the decision is frequently used as a yardstick of success. This term is defined differently by different people, but von Winterfeldt and Edwards (1986a) provide a common definition: Rational decision making "entails selecting ways of thinking and acting to serve your ends, goals, or moral imperatives, whatever they may be, as far as the environment allows." Gathering information as methodically and fairly as feasible under the circumstances is also part of rational decision-making. It necessitates examining both evidence that supports and evidence that contradicts your first inclinations.If you go out to buy a new mobile phone and choose one that looks good in your hands but ignore other factors such as operating system, reliability, and software availability, you are undermining your own decision-making.

According to Kathleen M. Galotti, decision making can be divided into five main phases.

- Setting Goals
- Gathering information and Making Plans
- Structuring the decision
- Making a final choice
- Evaluating a decision

As shown in the following Figure 5.1, there is a particular order in which these phases usually occur. However, this order is not necessarily be followed in every decision-making process. Sometimes, you may have to revisit and redo certain phases which make this procedure cyclical as shown by the arrows. Also, some of the phases can be skipped and performed in a different order rather than performing in a set order

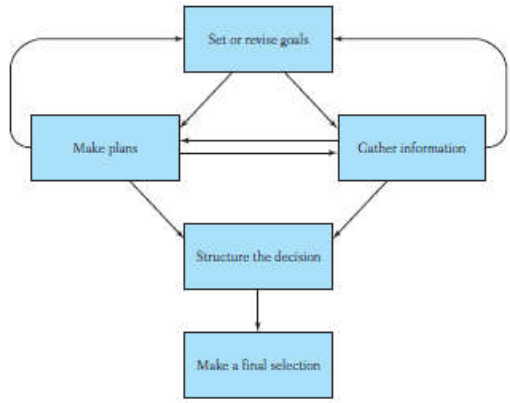

Figure 5.1 Phases of Decision Making

{Source: Galotti, K.M. (2014). Cognitive Psychology: In and Out of the Laboratory. (5th ed.). Sage Publications (Indian reprint 2015).}

5.1.2 Theoretical Models of Decision Making:

It will be interesting to know howdo we make decisions, ranging from less important like which dress to wear today to moderately important like where to go for a vacation to a very important decision like which career to choose. Are there any ideal ways to decide which would always lead to the best answer? For centuries, these questions have been of great interest to a wide range of researchers in different disciplines. Economists, philosophers, mathematicians, and, more recently, psychologists,all have attempted to answer the question of how to make the best decision. Economists, philosophers, and mathematicians have focused on ideal decision-making methods and, as we will see, have devised methods for making the best choices in small-scale, well-defined decision tasks, such as simple gambles. The normative approach refers to the search for good ways to make decisions. Psychologists, on the other hand, take a descriptive approach, attempting to understand what people actually do rather than what they should ideally do. As we will see, normative approaches provided ideas that were then used in descriptive theories. Economists are beginning to develop behavioural-economics theories based on descriptive theories that make more realistic assumptions about human thinking. As a result, there has been considerable interaction between descriptive and normative approaches. There is also an approach known as prescriptive approach.

- **Normative approac**h- It attempts to establish **norms i.e.ideal ways of deciding** that will give the best decision possible. It defines ideal performance under ideal circumstances. Economists tend to develop normative models.Normative approach of decision making is also known as the classical theory of decision making.

- **Prescriptive approach**- Ittell us **how we "ought" to make decisions**. They take into account the fact that circumstances in which decisions are made are rarely ideal, and they provide guidance about how to do the best we can. Teachers try to get students to follow prescriptive models.

- **Descriptive approach**- It aims to **describehow decisions are taken** against how they should be made. Psychologists tend to focus on the descriptive approach.

In this unit, we will study some theoretical models of decision making namely- Expected Value Theory and Prospect Theory. While learning these approaches we will understand the concepts of risk in decision making, utility , subjective probability and prospect theory. This unit also deals with how we make probability judgments and how people use heuristics to take a mental shortcut while making decisions. So, before we go ahead and study theoretical models of decision making, let us first understand the following concepts:

Concept of Risk in Decision Making-

Decision problems may differ from each other in several ways. One major difference between different decision problems is that some decision problems involve risk as against those that are risk less.

- If there is a probability that one of the options could lead to negative outcomes for the decision-maker, we say that the decision problem involves risk.

- Risk less decisions involve choices where the outcomes of the choices are known with certainty. Thus, the negative outcomes can be minimized by choosing the appropriate alternative.

If you decide to bet that a particular team will win a match that is a risky decision. Because the result of the bet is unknown when you make this decision. In such a situation the chance that you win or lose are almost similar. On the other hand, deciding which coloured shirt to wear is risk less. If you choose the blue shirt then that is what you will be wearing and you won'tloose anything.

Single Attribute and Multi-Attribute alternatives-

Decision making becomes more difficult and complicated when there are many alternatives and these alternatives differ from each other based on different attributes (**Multi-attributes**) as against those objects which vary in only one way **(single attribute).** For e.g. when you have to choose which tie to wear, you might have to select from different ties which may be identical except for colors. Here there is only one attribute of the object i.e. colour. Multi-attribute decision problem is a decision task in which the alternatives vary in many dimensions or aspects. For e.g. when you have to buy a new mobile phone you might have to consider different aspects in order to select one like operating system, size, weight, colour, camera quality etc.

5.2 EXPECTED VALUE THEORY

While looking for ways to avoid risky gambles, mathematicians Blaise Pascal (1623–62) and Pierre de Fermat (1601–65) proposed that people should act to increase the expected value of choices. What does this mean?

The expected value of a risky choice is the average result you would get if you repeated the action many times. For example, if a lottery ticket had an 85% chance of winning 100 rupees, its expected value would be 0.85 × 100 rupees, that is 85 rupees (an average). If you can repeatedly take the same risk (i.e. your lottery ticket is valid every week and has the same chance of winning), you would get nothing sometimes (15 per cent of the time) and you would get 100 Rs the rest of the time (85% of the time). So a long-term average over all the purchases is 85 rupees. Looking at this example using the expected value model, you should be willing to buy the lottery ticket for any price under 85 rupees as it would mean you would profit overall (even if it is only a small profit). Even buying the ticket for 84.99 rupees would be considered rational because you would make something, even if it is only 1 rupee.

The expected value approach is one of the best ways to deal with risky decisions, for example in situations where we can put a money value on the possible outcomes and can say exactly what the probabilities of the possible outcomes are.

Can the expected value model predict people's real life behaviour?

Research suggests it does not. Kahneman and Tversky (1984) with similar decisions to the lottery ticket case found that people's choices showed differences from the expected value model predictions. Many participants made choices that made them poorer. If they had all followed the expected value approach, most would have been richer at the end of the experiment than when they started.

Real life shows a different scenario from what expected value model would predict. For example, why do most of us get insurance? To stay in business the insurance companies gives in claim payments less than they take through charges to customers. Overall the average customer must lose, that is paying in more than they get back. So, from the expected value point of view people should not take out insurance. Overall, these examples make it clear that the simple expected value model does not fit actual behaviour very well. Further theories highlighting subjective probabilities and subjective measures of value (utility) have been developed to overcome the problems related to expected value theory and provide better explanations.

5.3 UTILITY AND PROSPECT THEORY

Utility-

The concept of utility versus objective value has a lengthy history, dating at least as far back as the eighteenth-century mathematician Bernoulli (1738). Utility is the subjective value of an option. The subjective value or utility of a given additional quantity of money diminishes the more money you already have, according to utility theory. A plot of utility vs money should theoretically show diminishing returns. Figure 5.2 depicts our intuition that an additional 100 Rs is more valuable to a poor individual than it is to a billionaire.

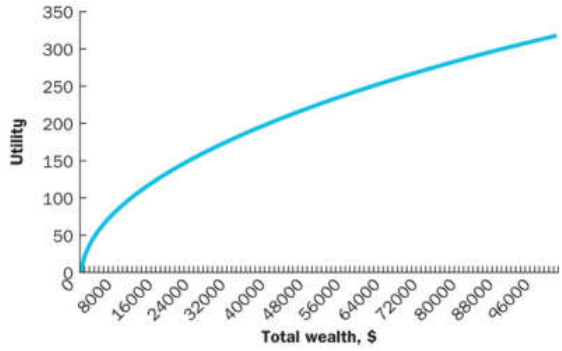

Figure 5.2- Plot of utility versus money. This figure shows diminishing growth of utility of extra wealth as wealth grows.

{Source: Gilhooly, K., Lyddy, F., &Pollick, F. (2014). *EBOOK: Cognitive Psychology*. McGraw Hill.}

Let's understand utility by using this example- A poor person might cross a busy road to pick up a 100 Rs note, whereas a rich person would not, because the 100 Rs has vastly different utility for the rich and the poor.

Prospect Theory-

Prospect theory was developed by psychologists Daniel Kahneman and Amos Tversky, originally published in 1979 in Econometrica. To overcome issues with the expected value approach, Kahneman and Tversky developed prospect theory. The theory explains how people make decisions about which gambles (or 'prospects') to take and, more crucially, it extends the utility plot into the realm of losses.Prospect theory is a theory of decision-making stressing relative gains and losses.

Loss aversion is a key idea of prospect theory that there is a greater dislike of losing utility than liking for gaining the same degree of utility. Prospect theory, also known as Loss-Aversion theory, is a theory of decision-making under conditions of risk. The model has been imported into a number of fields and has been used to analyse various aspects of political decision-making, especially in international relations. The theory was mainly based on human decision making while handling financial prospects relating to betting / gambling. Prospect theory assumes that individuals make decisions based on expectations of loss or gain from their current position. As shown in the figure 5.3, the S shaped curve shows a steep fall with losses and more gradual growth with gains

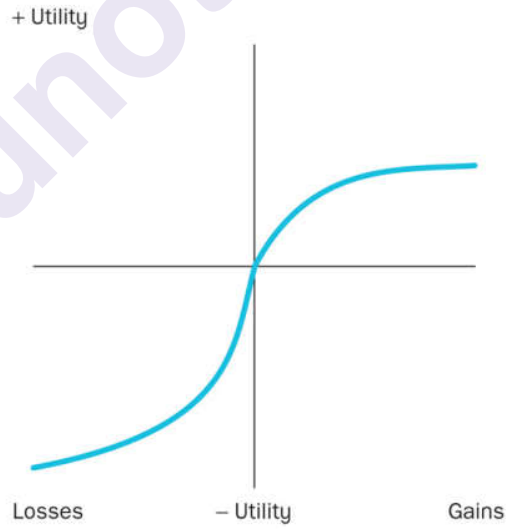

Figure 5.3- Schematic plot of gains and losses versus utility according to prospect theory.

{Source: Gilhooly, K., Lyddy, F., &Pollick, F. (2014). *EBOOK: Cognitive Psychology*. McGraw Hill.}

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5.4 SUBJECTIVE PROBABILITY AND PROSPECT THEORY

Subjective and Objective Probability-

Depending on the nature of calculation or determination, there are **two types of Probabilities**.

-The one that uses personal opinion is known as **Subjective Probability**

-While the one that uses history and data is known as **Objective Probability.**

Of course, probability estimates can differ from one person to another or from one time to the next. For example, when someone is in a bad mood, his/her estimates of the likelihood of success in one of his/her ventures are much lower than when he/she is happier. Optimistic people always seem to find successful outcomes more probable than do pessimistic people. Subjective probabilities are influenced by characteristics of the probability estimator whereas objective probabilities are not. They are based on facts. Of course, in many real-life circumstances, there may be no objective probabilities available.

Prospect theory addresses the issue of probability as well. Both objective values and known objective probabilities were assumed in the expected value model.

As we have seen, prospect theory replaces objective values with subjective values or utilities. It also proposes that people's perceptions of probability deviate from objective values on a regular basis. Kahneman and Tversky (1979), in particular, proposed that objective probabilities be transformed into subjective probabilities known as 'decision weights.' As shown in Figure 5.4, people tend to overestimate small probabilities and underestimate large probabilities. This figure shows that decision weights (the solid line) are overweight low probabilities and underweight high probabilities. The dotted line shows what would happen if the decision weights become equal to the objective probabilities.

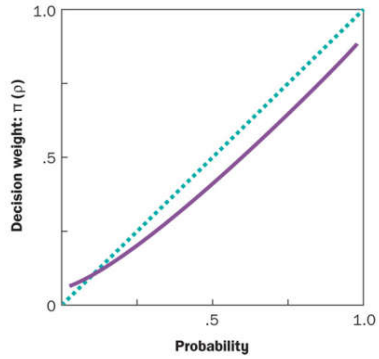

Figure 5.4: Decision weights versus probability

{Source: Gilhooly, K., Lyddy, F., &Pollick, F. (2014). *EBOOK: Cognitive Psychology*. McGraw Hill.}

Phases of prospect theory-

Prospect theory contains two phases:

(1) An editing phase- The editing phase refers to the way in which individuals characterize options for choice. Usually, these are referred to as **framing effects.**

(2) An evaluation phase -People tend to act as though they would make a decision based on the possible outcomes and choose the option with the most utility during the evaluation phase. Each prospect's outcomes are measured and compared using statistical analysis at this phase. The value function and the weighting function are two indices that are used to compare prospects throughout the evaluation process.

5.5.1 Framing Effects-

Framing effects highlight the way in which someone's choice can be affected by the order, method, or wording in which the matter is presented i.e. how the matter is framed. An example of this effect took place in the Asian disease paradigm in which people were asked to make a choice among public policy plans for responding to a disease outbreak. Even though the actual probabilities were identical, the percentage of people supporting a plan changed based on whether or not the outcomes were presented in terms of the number of people who would live versus the number of people who would die. We will see this example in detail in following discussion.

Let's take simple everyday life example. Suppose, you are a health-conscious person . You went to the grocery shop for buying a yogurt. On the rack you see two different sachets of yogurt. On first sachet it is written "contains 20% fats". On another one it is written "80% fat free". What will the immediate choice in this situation? Most people would choose second option. But if you really pay attention both the yogurt contains same amount of fats. This is how framing effect, how the problem is worded/ presented has effect on decision making.

People evaluate outcomes in terms of changes from a reference point (which is their current state). They perceive certain outcomes as gains or losses depending on how their current state is described. As a result, the description is said to "frame" the decision, or to provide context for it. We have seen in previous cognitive topics (such as perception, thinking, and reasoning) that context effects can have a significant impact on cognitive performance. In essence, framing effects are similar to context effects in decision making.

Another example includes patients suffering from cancer choosing between surgery and chemotherapy for treatment of their illness. The

choices are greatly based on whether the outcome was presented in terms of survival rate or mortality rate.

In the evaluation phase people tend to show aversion of loss and there are certain factors at play - which are as follows.

Certainty effect: People tend to value certainty over outcomes that are merely probable. Tversky and Kahneman (1986) used the following examples to demonstrate the certainty effect-Consider the following scenario:

Which option do you prefer out of the following?

A. a guaranteed profit of Rs. 300.

B. An 80% chance of winning Rs 450 and a 20% chance of winning nothing.

Option A was chosen by 78 percent of participants, whereas option B was chosen by only 22 percent. As the projected value of option B (Rs 450 x0.8=Rs 360) exceeds that of option A by 20%, this exhibits the classic risk-aversion phenomenon in prospect theory and the framing effect.

Reflective effect: When it comes to positive gains, people give more importance to a small but certain profit/gain over a larger but probable gain. Although, when it comes to negative gains, people show risk-seeking behaviour. For example, people prefer a loss that is probable over a small loss that is certain. This seems to contradict people's desire for safety and insurance, but it is for moderate losses, rather than severe losses.

Related research:

Tversky and Kahneman wanted to study different impacts of framing decisions in terms of potential losses as against potential gains. For this research they created a scenario where people would have to decide how to deal with an imaginary Asian disease. The options for treating the disease could be framed and presented in terms of gains (lives saved) or losses (lives lost). Prospect theory predicts that these different ways of presenting the alternatives would have an impact on the choices made, so that a risky option would be preferred when the choices were among losses and a sure option would be preferred when the choices were among gains. People were asked the following:

The first problem asks, if programme A is adopted, 200 people will be saved. If programme B is adopted, there is a one third probability that 600 people will be saved and a two-thirds probability that no people will be saved. Then the participants were asked to choose one of these two options. Now the second problem poses these questions: if Programme C is adopted, 400 people will die. If Programme D is adopted, there is a one-third probability that nobody will die and a two-thirds probability that 600 people will die. Which programme should be chosen?

The results show that in the first problem people preferred program A over program B. Whereas in the second problem there was a strong preference for program D over program C. The researchers further explained that in Problem 1, participants are inclining towards a positive 'gains' frame, i.e. in terms of lives saved. Whereas, in the second problem the participants were working in a 'losses' frame, i.e. in terms of lives lost.

5.5 MAKING PROBABILITY JUDGEMENTS

You must be aware that most difficult decisions are made under uncertain conditions. Deciding on a major would be a very easy and simple task if you knew in advance how each of the available alternatives would lead to your life. In such an ideal situation, you would simply go through all the outcomes and choose the alternative that led to the outcome that fulfils the need of your decision-making and which you most prefer. However, people rarely have such an ideal decision-making environment. Mostly, real-life decisions are based on uncertainty and risks.Thus, such real-life decisions rely on estimating the chances of different outcomes of different alternatives. To understand how people do this, first, it is necessary to understand some concepts related to probability and uncertainty.

5.5.1 What is Probability?

In the light of uncertainty and risk involved in decision making, another important concept becomes necessary to understand while we are studying decision making and that is probability. As per Von Winterfeldt& Edwards, Probability can generally be thought of as a measurement of a degree of uncertainty. Probability is a mathematical concept that is represented by a number between 0 and 1, where 0 represents complete certainty that an event will not happen, and 1 represents complete certainty that it will. Intermediate values can be thought of as corresponding to intermediate levels of confidence that an event will occur. Someone who says the probability of an event to be .15 is saying that the probability of the event taking place is very low.

Application of Probability Theory in Decision Making-

Probability is the branch of mathematics concerned with the assessment and analysis of uncertainty. The theory of probability provides the means to rationality model,analyze and solve problems where future events cannot be foreseen with certainty. It is difficult to ascertain the results to be obtained when choosing a course of action. In such cases, if one wants to act rationally i.e. to maximize the chances of attaining one's goal— it is necessary to explicitly deal with the uncertainty created by the problem. Thus, probability theory is crucial for rational decision-making.

In general, people who are not trained in probability theory will have little trouble with a probability of 0 or 1. They are not very good at using the intermediate probabilities in a coherent way. Their use of middle numbers deviates significantly from probability theory, and it's not hard to see why. What does it mean to say you are 60% sure about something, and how is

that different from being 70% sure? What these numbers "mean" in the context of a real-life decision is not at all intuitive and is rather subjective.

If we think ofdefinition of probability, it says it is the number of favourable events, divided by the total number of events. Let's take an example. You've surveyed 50 customers to know if they are satisfied with your service. Out of them, 35 said they are happy.

Based on that information alone, can you predict what's the attitude (happy) of a random customer? You can make such predictions with probability:

35/50 = 0.7 which means, there's a 70% chance that an out-of-sample customer will have a positive view of the service. That's *probability* in the simplest terms — the likelihood of something happening.

The above example has only 1 outcome — customers' *positive* attitude. However, some customers may demonstrate other preferences such as *negative* or *neutral* attitudes. For multiple outcomes such as those, calculating probability is slightly different.

Probability judgments in Decision Making-

While choosing effectively between options the decision-maker has to reach judgments about the probability of certain scenarios. For instance, a business traveller in Mumbai might have to decide whether to travel by plane to Delhi or take the train. What outcomes might be considered and the subjective probabilities given to those outcomes will be critical in what decision is made. Tversky and Kahneman argue that availability heuristic and representativeness heuristic are most commonly used in making probability judgments. But what does the heuristic mean? And what is the relevance of it in decision making? Let's understand in detail what heuristics exactly means and how do availability and representativeness heuristics.

5.5.2 Heuristics-Mental Shortcuts!

A heuristic is a mental shortcut that allows people to solve problems and make judgments quickly and efficiently. Heuristics are rules-of-thumb that help to facilitate decision-making based on a limited subset of available information. As heuristics are based on less information, they are assumed to make faster decisions than strategies that require more information.These mental short cuts are generalizations or rules-of-thumb, reduce cognitive load and can be effective for making immediate judgments/decisions.

Why and When We Use Heuristics?

Here are a few different theories from psychologists about why we rely on heuristics.

- **Attribute substitution**: Simpler but related questions are substituted for more complex and difficult questions.

- **Effort reduction**: Heuristics are used by people as a form of cognitive laziness to reduce the mental effort required to make choices and decisions.

- **Fast and frugal**: People use heuristics since they are quick and accurate in certain situations. Some theories contend that heuristics are more accurate than biased.

Here are some conditions which explain **when we** use the heuristics-

- When one is faced with too much information
- When the time to make a decision is limited
- When the decision to be made is relatively less important
- When there is access to very little information to use in making the decision
- When an appropriate heuristic happens to come to mind at the time of making decision

To deal with the enormous amount of information we encounter and to speed up the decision-making process, the brain relies on these mental strategies to simplify things so we don't have to spend endless amounts of time analysing every detail.

Every day, you probably make hundreds, if not thousands, of decisions. What should you eat for breakfast? What should you wear today? Should you drive or take the bus? Fortunately, heuristics allow you to make such decisions with relative ease and without much agonizing.

For example, when deciding whether to drive or take the bus to work, you may suddenly recall that there is road construction along the bus route. You are aware that this may cause the bus to stall**.** Heuristics allow you to quickly think through all of the possible outcomes and arrive at a solution.

5.5.3 Availability Heuristic

This heuristic, according to Kahneman and Tversky, is a mental shortcut for making frequency or probability assessments based on "the ease with which instances or occurrences can be called to memory." Making decisions based on how easy it is to recall information (how easily the information gets available to your memory loop) is known as the availability heuristic. When making a decision, you may recall a number of relevant examples fast. Because these are more easily available in your memory, you are more inclined to assess them as more common or usual.

Because we can call certain memories to mind more easily than others, we apply the availability heuristic. The example Kahneman and Tversky give for availability heuristic is that when they asked participants if there are more words in the English language that start with the letter K or have the third letter K, the majority of them said the former. In reality, the latter is correct, however coming up with words with K as the third letter is far more difficult than coming up with words that begin with K. In this

scenario, recollections of words beginning with K are more readily recalled than memories of terms beginning with the third letter K.

Let's look at another example. If you are planning to travel to Delhi by flight and are reminded of a number of recent airline mishaps, you may decide that flying is too risky and opt to travel by vehicle instead. The availability heuristic causes you to assume that plane crashes are more common than they are since those examples of aviation disasters came to mind so easily.

In one of the study, Ross and Sicoly (1979) polled 37 married couples (husbands and wives separately and independently) on the estimated extent to which they take the responsibility for various household tasks, such as cooking, breakfast, grocery shopping, and child care etc. Husbands and wives were both more likely than their partners to say they had more responsibility for 16 of the 20 activities required the presence of a spouse. Furthermore, when asked to provide specific examples of contributions to each activity made by themselves and their spouses, each spouse listed more of her or his own activities than her or his spouse's activities.

The availability heuristic was used by Ross and Sicoly (1979) to explain these findings. We are more aware of and accessible to our own efforts and actions than we are aware to the efforts and behaviors of others. After all, while we are always present when we conduct an activity, we may or may not be there when a friend or spouse does. In general, we have greater access to what we do, think, say, or intend than anyone else, and to the thoughts, deeds, words and intentions of someone else.

Availability can be a reliable and effective heuristic. If we can be certain that the ease with which we can build or recall examples is unbiased, it may be the finest, if not the only, tool we have for gauging frequency or likelihood. If you're attempting to figure out if you do more papers in psychology or philosophy, it's generally a good idea to measure the frequency of papers by recalling individual paper assignments for each subject. There is probably no reason to suppose that psychology articles are more remembered than philosophy papers in this circumstance. If there is (for example, you took philosophy three years ago but psychology this semester), the comparison is most likely unfair.

However, using availability to determine which happens more frequently, hours you spend working on a group project or hours someone else spends working on the same project, may be unjust. You were present whenever you worked, but you may not have been present at all times when other members of your group worked. Even if you had been present, you would have been focused on your own work and planning rather than your partners' work and preparation. As a result, examples of your own work are more likely to stick with you and be more accessible than examples of other people's work. So, using availability in such situation won't be accurate.

The purpose of exhibiting the availability heuristic isn't to intimidate you. You'll be kept away from it if you don't use it. Instead, like with all other

heuristics, the goal is to make recommendation that first consider whether the range of examples you're considering is indeed adequately available.

5.5.4 Representativeness Heuristics

Making a decision using the representativeness heuristic involves comparing the current situation to the most representative mental prototype. When making probability judgments, we frequently rely on this heuristic. We have a tendency to categorize events, which, as demonstrated by Kahneman and Tversky, can lead to the use of this heuristic. When we use the representativeness heuristic, we make probability judgments about the likelihood that an object or event arises from a given category based on how similar the object or event is to the prototypical example of that category. For example, if we meet someone in one of our university lectures who look and acts like a stereotypical medical student, we may judge the likelihood that he/she is studying medicine, even if there is no hard evidence to support that assumption.

The research shows that we often use the representativeness heuristic; we judge that a sample is likely if it is similar to the population from which this sample was selected. We believe that random-looking outcomes are more likely than orderly outcomes. Suppose, for example, suppose the total of your grocery bill comes out to be 374.50 rupees. This very random-looking outcome is a representative kind of answer, and so it looks ‘‘normal.’’ However, suppose that the total bill is 444.44 rupees. This total does not look random, and you might even decide to check the arithmetic. After all, addition is a process that should yield a random-looking outcome.

Determinants of Representativeness:

Similarity: When judging the representativeness of a new stimulus/event, people usually pay attention to the degree of similarity between the stimulus/event and a standard/process.

Randomness: Irregularity and local representativeness affect judgments of randomness. Things that do not appear to have any logical sequence are regarded as representative of randomness and thus more likely to occur.

When people rely on representativeness to make judgments, they are likely to judge wrongly because the fact that something is more representative does not actually make it more likely.

Tversky and Kahneman devised a study of the effects of representativeness. They presented people first with information about an imaginary person (Linda) such that the information evoked the stereotype of a feminist. As it was made clear that Linda fits the description of a feminist, the researchers were curious to know whether this impression will make people guess other attributes Linda might have. The description of Linda framed to be representative of a feminist (F) and not

representative of a bank employee (T). A group of 88 students then ranked eight further statements about Linda by 'the degree to which Linda is similar to the typical member of that group. The description given and the eight statements were as follows: Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Now rank the following statements according to how likely you think they are to be true of Linda.

1) Linda is a teacher in elementary school

2) Linda works in a bookstore and takes Yoga classes

3) Linda is active in the feminist movement (F)

4) Linda is a psychiatric social worker

5) Linda is a member of the League of Women Voters

6) Linda is a bank teller (T)

7) Linda is an insurance salesperson

8) Linda is a bank teller and active in the feminist movement (T and F)

Most people opted for describing Linda as F, rather than T. And to the researchers surprise more people voted for 'T and F' rather than choosing T or F individually.

Most individuals get this problem wrong, according to Tversky and Kahneman, since they make use of representativeness: Option 2 appears to be a more "representative" of Linda based on her description, despite the fact that it is mathematically less likely.

Conjunction Fallacy: Error in Representativeness Heuristic-

The Conjunction fallacy (also known as the Linda Problem) is a formal error that occurs when distinct/ two different situations are thought to be more likely than a single generic one.It is an error in decision making which may appear when one uses representativeness heuristic**.** When the probability of conjunction (combined) events is judged to be more likely than either of its constituents.

A conjunction error occurs when a person rates a combination of two events as more likely than one of the events alone; the conjunction fallacy refers to this tendency in general. This distinction is essential because a reasoner can make these errors without having a bias toward making them in general, just as people can make bets with good expected value in general but yet lose money on specific bets.

5.6 THE AFFECT HEURISTIC

The Affect heuristic is a type of mental shortcut people use wherein their decisions are influenced by their current state of mind, the emotions

(affect) they are feeling. Often when people say they've relied on their "gut-feeling" to make a decision - they are making use of affect heuristics. So how exactly do our emotions influence our decisions? Well, researchers have found that people are more likely to perceive high benefits and low risks in an activity when they are in a positive state of mind. Hence, they're more likely to opt "for" the decision than go against it. On the contrary, when people are experiencing negative emotions such as anger or sadness - they are more likely to perceive the threats from the given stimulus and opt to go "against" it.

Affect heuristic involves substituting feelings (positive or negative) for target attributes in decision problems.

Children often instinctively make use of this heuristic while asking for parent's approval. Such as the vacation with friends that you had planned - you have waited for your parents to be "in a good mood" till you ask for their permission to go.

These little incidents aside, many times people often misuse the existence of affect heuristic to manipulate masses. Such as presenting smoking or eating junk food as appealing and positive. In such cases the use of affect heuristic can lead to long-term negative consequences such as poor health decisions. Thus even though using heuristics in decision making can be a quick short term fix - it cannot be a substitute for other elaborate strategies.

How to avoid the error?

You must have heard people saying "Never take an important life decision when you are too happy or too angry!". It really is meaningful.

We can begin to avoid the affect heuristic by becoming more conscious of how our emotions can influence our decisions. Simply being aware of the fact that we tend to get influenced by our emotions might save us from poor decision making. When faced with a major decision, we can avoid using mental shortcuts by thinking logically about the decision and examining all available possibilities.

Being conscious of one's emotional condition is also beneficial in avoiding the affect heuristic. We can accept that our emotions have the capacity to influence our decision-making, which can lead to cognitive errors, if we can recognize that we are feeling a specific way, such as happy, sad, or furious.

Finally, if we're faced with a major decision while feeling highly emotional, whether it's a positive or negative emotion, it's a good idea to delay making the decision until our emotional state returns to normal. This will ensure that our decision is not influenced by strong emotions.

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5.7 SUMMARY

We have reviewed some of the major concepts and research findings in the field of decision making in this chapter. We got the introduction to the concept of decision making where we understood what do we mean by decision making and different phases of decision making.

We saw that decision problems were characterized according to whether they were risky or risk less, or whether they had a single attribute or multiple attributes.

Decision-making approaches were classified as normative, prescriptive and descriptive. Normative models attempt to characterize the behaviour of a rational decision maker in an ideal world. The descriptive models explain how decisions are actually taken as against how they should be. In this unit we learnt about the most famous normative model of decision making i.e. expected value theory of decision making. As per this theory, people should act to maximize the expected value of a choice. This approach is an optimal in the risky scenario where we can apply monetary value on the outcomes of the different alternatives.

However, the expected value maximization model, the simplest normative model, clearly does not fit individual behaviour. This is due in part to the fact that the subjective value (utility) of money, for example, is not a simple linear function of money amounts, and people tend to over-weight very small probabilities while under-weighting high probabilities. We learnt the concepts of utility (subjective value) and subjective probability in relation to Prospect Theory. Prospect theory of decision making was developed to overcome the issues with the expected value theory. It stresses the relative gains and losses. The prospect theory approach fits a lot of the data, including the effects of framing, which lead to violations of basic rationality principles in the form of certainty and reflective effect.

Since risky decisions require that decision makers take account of probabilities, the question of how people handle probability information has been tackled in a number of studies. Tversky and Kahneman (1974, 1983) have provided many demonstrations of how inappropriate usage of heuristics such as availability, representativeness and affect can lead to misjudgements and errors in decision making and how to avoid it.

5.8 QUESTIONS

Q.1.What is Decision Making?

Q.2.What do you mean by normative and descriptive models of decision making? Explain the expected value theory as a normative model.

Q.3. What do you mean by Heuristics in Decision making? Explain the Availability and representativeness in brief.

Q.4. Explain Prospect theory in brief.

Q.5 Write Short notes on-

A) Subjective Probability and Prospect Theory

B) Framing Effect

C) Affect Heuristic

Activity-Take a real-life scenario and explain experience of Availability and Representative Heuristic in real life.

5.9 REFERENCES

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6

DECISION MAKING – II

Unit Structure

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6.0 OBJECTIVES

- To explain different decision making processes for multi-attribute alternatives including MAUT, Satisficing, Elimination by aspects.
- Understanding roles of system 1 and system 2 (Two-Systems approach) in the decision-making process
- Understanding how the heuristics can be helpful and adaptive and not just ways of making cognitive errors
- To learn naturalistic decision making and real-life application of it
- Understanding the Neuroeconomics and decision making- neural/ brain underpinnings in relation to decision making specifically financial decision making

6.1 DECISION MAKING PROCESSES FOR MULTI ATTRIBUTE ALTERNATIVES

The majority of real-life decisions involve choosing between complex alternatives that differ in a variety of ways. For example, when purchasing a new laptop, there are numerous functions that vary in quality and ease of use. What is the operating system? What is the resolution of the screen? What is the storage capacity? How simple would it be to view video on the screen? Or to read lengthy documents? What is the laptop's size? How long does it take to charge a battery? What is your financial budget and does it matches with the price of the laptop? How long will you be bound by the contract? And so forth. This is an example of deciding between alternatives that differ in a variety of ways. How does one reconcile cost advantages with disadvantages such as battery life or screen resolution? The general issue that many people face to decide between different attributes of the alternatives.

As we saw in the previous unit, decision making becomes more difficult and complicated when there are many alternatives and these alternatives differ from each other based on different attributes (multi-attributes) as against those objects which vary in only one way (single attribute). As explained in the above example, multi-attribute decision problem is a decision task in which the alternatives vary in many dimensions or aspects.

In the following section we will discuss about what criteria should be used to make such decisionsAnd how do they appear to be made.

6.1.1 Multi Attribute Utility Theory-

A model that provides a means of integrating different dimensions and goals of a complex decision is called Multi-Attribute Utility Theory (MAUT). Choosing between items that differ in many ways can be difficult, even if no risk is involved in choosing the alternatives. Multi-Attribute Utility Theory (MAUT) is a normative model.That is, if people follow MAUT, they will maximize their own utility in the best way for them to achieve all of their goals.

MAUT involves the following six steps:

(1) Identifying the relevant attributes/ dimensions for your decision- For choosing a specialization for your master's, you may find out that difficulty level, appeal, applicability to career, reputation of college, and past experience as the five attributes that you would like to consider while taking the decision.

(2) Determining the relative weights of each dimension- In this the relative importance of the attributes would have to be considered. Is applicability to career is more important consideration than past experience?

(3) Listing all the alternatives- you will list down all the alternatives that you are thinking as options to choose your majors from like psychology, political science, economics, philosophy, etc.

(4) Ranking the alternatives along the attributes- In this step, you will score each alternative for five attributes that you have identified in the first step. You have to use same scale length for all attributes (For e.g. 0-100 or 1-10 etc)

(5) Multiplying the ranking by the weighting of each alternative to determine its final value- Now you need to multiply weight of a particular dimension with rank given for that dimension for that option. For example, You have given weight of 10 to applicability dimension and college B has received rank of 3 on that. College B's score for that dimension then will be 20×3=60. Then you will obtain obtain a total utility for each object by summing the weighted attribute values.

(6) Choosing the alternative with the highest value- So, you will choose the one alternative which scores highest.

This method of decision making is most suitable for situations wherein consideration of multiple domains or contributing factors needs to be taken into account.

Let us understand this model in simpler way as explained by Kopp &Slayter (1984) where they applied MAUT to decision of choosing a career which was created using a computer programme called as Decision Map.

Figures 6.1 to 6.3 show an example of MAUT applied to a major decision. Look first at Figure 6.1, which depicts the first two steps in MAUT. It displays the five dimensions listed in the previous paragraph, as well as any weightings assigned by a specific student. (Once again, weightings indicate the importance of a given aspect of the decision to the decision maker.)

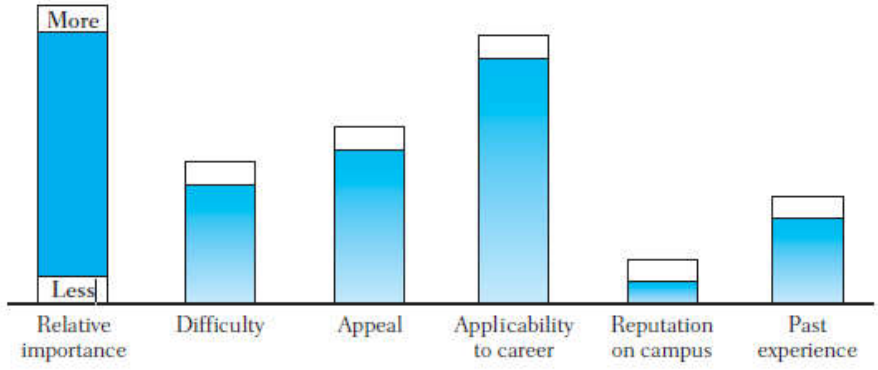

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Figure 6.1-*Weightings of five dimensions in the decision "choosing a major"*

{Source: Galotti, K.M. (2014). Cognitive Psychology: In and Out of the Laboratory. (5th ed.). Sage Publications (Indian reprint 2015).}

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The most important goal for this student is to select a major that is relevant to future career goals. Take note that the goal or dimension "applicability to career" has the highest value and thus the most weight in the graph. The appeal of the major, its difficulty, and the student's previous record of success in its courses are the next most important goals for this student. This student has given the goal "reputation on campus" very little weight, indicating that it is of little importance. The fact that these weights are subjective and would differ for different students is significant. Your own weightings may differ greatly from those shown in this example.

Following the weighting of all dimensions, the decision maker must consider all alternatives and evaluate them on all of the dimensions described in the preceding paragraph. Part of this process is depicted in Figure 6.2, which shows the ranking of various majors on the dimension "applicability to career." Only four options are presented here: Chemistry, Psychology, Biology, and Art. Each of these alternatives would need to be rated on each of the dimensions identified in the first two steps by the student. As a result, there would be five graphs of this type, one for each dimension identified in Figure 6.1.

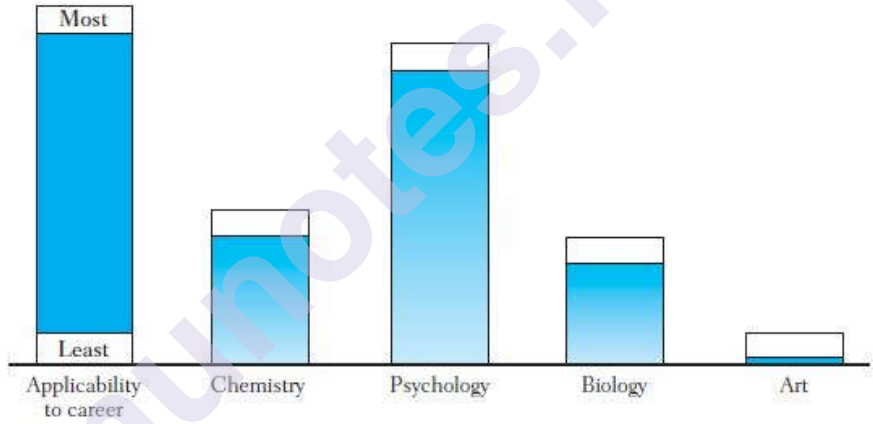

Figure 6.2-*Assessment of four possible majors on one dimension in the decision "choosing a major."*

{Source: Galotti, K.M. (2014). Cognitive Psychology: In and Out of the Laboratory. (5th ed.). Sage Publications (Indian reprint 2015).}

The fifth step in the MAUT process is depicted in Figure 6.3: compiling the assessments of alternatives on all dimensions, as well as the weights of those dimensions. According to the rankings and weightings provided earlier, psychology is the best alternative. Figure 6.4 explains why this is the case: Psychology outranks other alternatives on the dimension "applicability to career" but ranks close to the bottom on the other dimensions.

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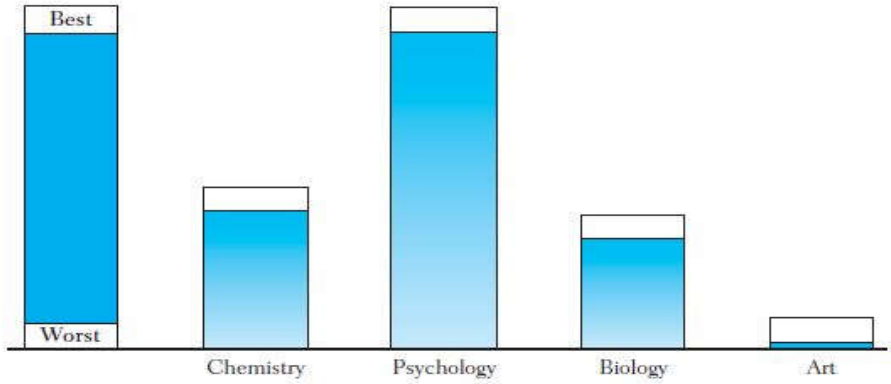

Figure 6.3-*Final choice of a major*

{Source: Galotti, K.M. (2014). Cognitive Psychology: In and Out of the Laboratory. (5th ed.). Sage Publications (Indian reprint 2015).}

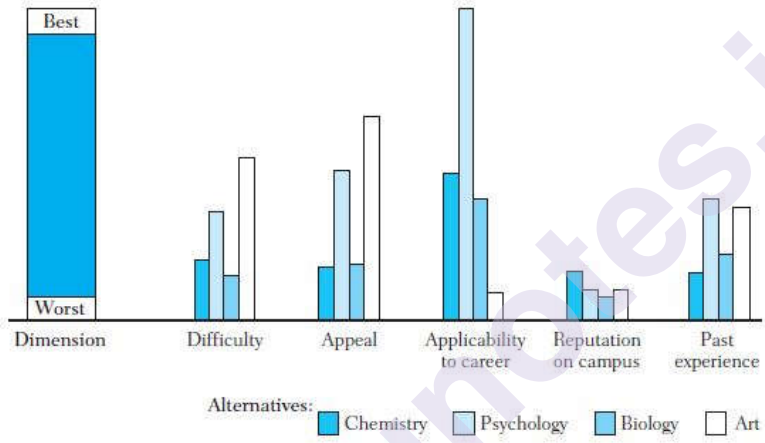

Figure 6.4-*An analysis of the decision "choosing a major."*

{Source: Galotti, K.M. (2014). Cognitive Psychology: In and Out of the Laboratory. (5th ed.). Sage Publications (Indian reprint 2015).}

To use MAUT in decision making, the dimensions listed must be independent of one another. For example, the possible dimensions "course difficulty" and "past grades in course" are presumably related. As a result, the decision maker must carefully select each dimension. The decision maker must then be willing to make tradeoffs between the different dimensions. Although the decision maker in our example is most concerned with future career goals, MAUT assumes that if an alternative's relative position on other dimensions was high enough to compensate, the person would be willing to choose it.

Though MAUT is one of the ideal way of dealing with a decision problem when faced with different alternatives having multiple attribute, unfortunately, little is known about whether people use MAUT on their own when making important decisions, particularly when the information relevant to the decision is extensive. We will discuss about it further in this section.

6.1.2 Elimination By Aspects

Tversky (1972) described a less demanding procedure than MAUT as a possible strategy that individuals could use to reduce cognitive effort or processing load. This method is referred to as elimination by aspects (EBA). In an EBA process, the chooser would first choose an attribute and then eliminate all options that did not meet some level of criterion on that attribute. In the case of a house purchase, for example, 'price' is usually a critical factor. The chooser will frequently have established a ceiling price, and any houses that exceed that ceiling price may be excluded from consideration (irrespective of their other desirable qualities).

If the chooser continues to eliminate alternatives in this manner, eventually only one option will be left, and the decision will be effectively made. EBA is clearly a less demanding procedure than MAUT's proposal. Depending on the order in which aspects are used to eliminate alternatives, very different choices can emerge. According to Tversky, the importance or weighting of attributes influences the order of elimination.

MAUT is a normative model, whereas Elimination by Aspects (EBA) can be considered as a descriptive model. It paints a picture of what people do in real life. It's debatable whether eliminating by aspects is the best way to make a decision with limited time or memory. It may be entirely rational in some cases. If an house seeker simply cannot afford a rent above a certain amount, it makes no sense to waste time looking at houses that are more expensive, regardless of how well they rate on other dimensions. In other cases, it may be necessary for decision makers to invest the time and effort in conducting an MAUT analysis. There are various types of decision aids (including computer-assisted ones) that may be useful.

6.1.3 Satisficing

Simon describes 'satisficing,' a further simplifying technique that could be used in decision making (1956, 1978). The basic idea is that rather than expending time and effort to maximise utility, most people are content to set a minimum acceptable level that will satisfy them but fall short of the maximum. This is especially true in the case of sequential decisions. In the case of buying a house, for example, houses come onto the market on a regular basis, making it difficult to determine whether a particular house was the best option because a better one might appear the next day.

As a result, buyers can set acceptable levels, either for total utility or for key aspects of the properties, and choose the first property that meets all of their minimum requirements. For example, one may only set criteria of house with X price and in Y locality. The first house that is suggested which fulfills this criteria is then selected. Should the initial minimum requirements prove too ambitious, Simon (1978) proposes that the satisficing level be gradually adjusted in light of market average values, so that, as a result of experience, the decision maker can become more realistic about his or her criteria.

6.1.4 Testing Multi Attribute Decision Models

As we pointed out previously, it is interesting to know how people take a decision when faced with a decision problem having different alternatives having multiple attributes. To figure out which (if any) of the major multi-attribute choice models are reasonably descriptive of behaviour, one must be able to deduce how humans process information during decision making. Payne (1976) did a study relevant to this aspect of decision making processes and contributed with unique findings which were beneficial in the research of decision-making processes. In Payne's (1976) study, when participants had to choose between alternatives having different attributes, the participants used simple (non-compensatory) techniques to reduce the number of options, then used compensatory methods such as MAUT to analyse the remaining few options more thoroughly. That is, they used mixed techniques, normative as well as descriptive to make a better decision.

Overall, research shows that when deciding between multi-attribute options, no single decision technique is always adopted. Rather, it appears that techniques are used to strike a balance between lowering cognitive load and enhancing the utility of the desired outcome. In general, cognitive burden of decision-making may be reduced by selecting at random, but the resulting decisions would be bad. By evaluating all alternatives on all important dimensions, integrating the resulting information for all alternatives, and picking the best, the quality of decision making would be maximized, but the information processing necessity would be extremely demanding. Participants generally strike a balance between effort and decision quality, and they may change methods during a task.

6.2 TWO SYSTEM APPROACHES TO DECISION MAKING

In day to day life, you'll undoubtedly notice that some of your decisions are made almost instantly with little or no conscious effort, while others take a long time to get at. Making decisions about less important topics, such as choosing curtains for living room, appear to be less effortful and more intuitive than making decisions about more complex alternatives, such as employment offers, say by utilising MAUT. From the psychological perspective, Evans (2003,2008), Kahneman (2003), Sloman (1996), Stanovich and West (2000), and others have recently highlighted the contrasts between intuitive and more reflective types of decision making in what are known as two-system approaches to thinking and decision making.Two different cognitive systems are proposed in these accounts- System 1 and System 2.

System 1 is thought to be automatic, implicit, quick, easy, and emotive, and it generates intuitive, immediate reactions.

In evolutionary terms, this system is thought to be rather old, and it is extremely similar in humans and other animals. Only the end result of

such processes is visible to consciousness, which means that the individual cannot explain why they made their decision.

System 2, on the other hand, is thought to be recent in evolution and unique to humans. It is closely connected with general fluid intelligence and performance on sequentially solvable issues, operates relatively slowly and sequentially, is unemotional, is restricted by working memory capacity, and allows abstract reasoning and hypothetical thinking. People can explain why such decisions were made. The two systems are thought to interact, with System 2 playing a key role in inhibiting and overriding System 1.

When System 1 is suitable, such as when the costs of errors are substantial, a gut reaction is unlikely to be the best basis for action and should be evaluated. Automatic System 1 processes, on the other hand, have a significant impact on what information a person responds to and concentrates on, and hencewhat information System 2 uses to make a decision (Evans, 2008).

Two-system view is that there are two modes of thought, System 1 and System 2.

System 1 is a hypothetical system that carries out rapid intuitive thinking.

System 2 is a hypothetical system that carries out slow deliberate thinking

Both, the intuitive System 1 and reflective System 2 paths can be taken while making decisions. Overall, System 2 will be more involved in meticulous analytical decision-making that aims to mix several forms of data in a rule-based method. System 2 processing would be expected for normative methods like those described by MAUT. System 1 will play a bigger role in decision-making based on heuristics and biases (Tversky & Kahneman, 1974) as well as gut feelings (Gigerenzer, 2007).

Although when dealing with formal probability problems, heuristics (such as availability) often lead to errors (as we saw for Linda problem), Gigerenzer has proposed that heuristics often have validity in the real world.

We will see further in the next section at this idea that how heuristics are adaptive and useful and not just sources of error.

6.3 FAST AND FRUGAL HEURISTIC: THE ADAPTIVE TOOLBOX

As the name implies, this class of heuristics is based on a small fraction of information, and decisions using the heuristics are made rapidly. These heuristics set a standard of rationality that considers factors including, time, information, and cognitive capacity. Furthermore, these models consider the lack of optimum solutions and environments in which the decision is taking place. As a result, these heuristics provide a good description of decision making during sports. Fast-and-frugal heuristics

can form a comprehensive description of how people behave in a variety of contexts. These behaviors vary from lunch selections to how physicians decide whether to prescribe medication for depression, to making business decisions. Following are two prominent examples of fast and frugal heuristics: theRecognition Heuristic, which exploits a lack of knowledge, and the Take the Best heuristic, which deliberately ignores information. Both heuristics can be applied to choice tasks and to situations in which a decision maker has to choose which of two objects has a higher value.

Recognition Heuristic: Suppose someone asks you which of two Italian cities have the larger population, Milan or Modena. Most students have heard of Milan, but they may not recognize the name of a nearby city called Modena. The recognition heuristic typically operates when you must compare the relative frequency of two categories.If you recognize one category, but not the other, so we tend to conclude that the recognized category has the higher frequency. In this case, you would correctly respond that Milan has the greater population.

Take the Best Heuristic: It was discovered by psychologists GerdGigerenzer and Daniel Goldstein as part of their research on human decision making. In a 2013 study, researchers found that experienced airport customs staff used the heuristic to select travellers for body searches. To aid in their decision, the officers used attributes such as nationality, amount of luggage, and airport of origin. People often use this type of decision making strategies while voting for political candidates. They tend to find 1 or 2 significant attributes of the candidate which they find to be the most important and vote accordingly. Such as someone from the agricultural industry voting for a candidate solely based on who supports their views on farm laws.

- **Why it is called as adaptive toolbox?**

The main difference between Gigerenzer's approach and Kahneman and Tversky's heuristics-and-biases approach is that Gigerenzer emphasizes the validity and adaptive value of real-life heuristics, whereas Kahneman and Tversky were more inclined to emphasize the errors that heuristics (such as availability) can cause. Heuristics appear to be most useful when dealing with ordinary scenarios, but they can lead to errors when dealing with abstract problems that require explicit computations based on logical and mathematical standards.

Overall, the heuristics established and investigated by Gigerenzer and colleagues function well because the decisions are based on some underlying fact in the environment that allows for successful shortcut solutions.

6.4 NATURALISTIC DECISION MAKING

Naturalistic Decision Making (NDM) is also known as Recognition-Primed Decision Making. Intuitive type of decision making is another name which is most commonly used in the corporate sectors while

studying this method. Klein (1998), Lipshitz et al. (2001), and Phillips et al. (2004) studied firefighter, nurse, police, and military decision-making in real-life events. This work is a more advanced variant of laboratory work that examines what happens in real-life situations. In actuality, the decision maker may not be given options to choose from, but instead must devise one or more possible actions.

It was found that recognition primed decision making was most common. For example, during a critical incident analysis if a police officer sees a man on the street hiding a knife, from his mannerisms the police officer might recognize that this was a situation of possible danger to other citizens and tries to isolate the man.

Findings show that in many critical situations only a single action was mentally generated and it was then executed. The basic that initially produced possible actions are often very appropriate was replicated in a study of expert chess players (Klein et al., 1995). The players were asked to think aloud while deciding their moves to sample positions and it was found that the very first moves that came to mind were rated as high quality and much better than chance by independent expert judges.

NDM community views intuition as an expression of experience as people build up patterns that allow them to quickly evaluate situations and make rapid decisions without having to compare options. Now what counts as expertise? NDM researchers identify experts as being able to make fine discrimination that may be invisible to novices, having sophisticated mental models of how things work, and having resilience to adapt to complex and dynamic situations.

6.4.1 Naturalistic Decision Making and Important Real Life Decisions-

Undoubtedly, we all agree that when compared to the more field-based naturalistic decision-making model, the relevance of laboratory-based decision-making theories like multi-attribute utility theory (MAUT) to actual life may appear dubious.

Is naturalistic decision-making, better suited to real-life situations where significant decisions must be made and people must respond without being under extreme time constraints?

- **What does the research say?**

Cognitive researcher Galotti compared the results of five real-life decision-making investigations to laboratory and naturalistic decision-making models (Galotti, 2007). Participants in these research discussed their experiences dealing with real-life choice dilemmas in areas such as –

- choosing a college
- choosing a major subject,
- choosing a birth attendant/helper and
- choosing a kindergarten.

Findings of this study showed that-

- Participants consistently considered fewer options and larger criteria/attributes.
- With time, number of options shrank but number of criteria did not.
- Participants subjectively rated the importance of their criteria, the value of each option on each criterion, and the overall attractiveness of each option.
- Fit of people's intuitive choices to the predictions of normative models (such as MAUT) was surprisingly good.
- People did consider a number of options in these non-expert decisions, as opposed to the 'one-option' decisions that are frequently seen in time-pressed expert naturalistic decision making, which is generally based on recognition (Klien, 1998).

Take the first option-

Overall, it appears that many 'decisions' made by experts in real life do not involve conscious decision making between alternatives. Based on interviews with Klein and colleagues, it appears that a heuristic known as 'take-the-first-option', identified by Gigerenzer (2007), can and is effectively used by experts in time-critical situations.

The naturalistic decision-making approach then strongly supports the use of fast and frugal heuristics, particularly those based on expert recognition, in real-life situations requiring immediate responses. Again, in such time-pressed situations, System 1 intuitive processes are heavily involved. When decisions are important and time limitations are not stringent, people tend to approximate the more reflective, effortful decision processes suggested by MAUT, and these processes involve System 2.

6.5 NEUROECONOMICS: NEUROSCIENCE APPROACHES TO DECISION MAKING

6.5.1 What is Neuroeconomics?

Neuroeconomics is the study of neural processes underlying economic decisions.

Researchers have recently begun to use neuroscience technologies such as brain imaging and neuropsychological examinations of the effects of brain lesions on financial decision making to uncover neurological roots of decision making, resulting in the formation of a new hybrid field called neuroeconomics.

Neuroeconomics is indeed an attempt to bring neuroscience, psychology, and economics together. Using modern imaging and biochemical tests,

neuroeconomics investigates brain activity before, during, and after economic choices.

Neuroeconomics use wide variety of techniques to measure brain activity. Some of these techniques are so invasive, for example, single neuron recordings, that they can only be used on animals. Other techniques, for example, functional magnetic resonance imaging, FMRI, are less invasive and are able to measure the hemodynamic response, that is, the changes in blood flows to different parts of the brain. There are very recent techniques such as transcranial magnetic stimulation, TMS as well.

6.5.2 Link between Neuroeconomics and decision making-

- Reward system and decision making-

In primates, recordings from dopamine neurons (Tobler et al., 2005), the orbitofrontal cortex (Roesch& Olson, 2004; Tremblay & Schulz, 1999), and the posterior cingulate cortex (McCoy et al., 2003) have revealed neural responses that are directly related to reward size, and similar findings have also been reported in human studies with respect to monetary rewards (Elliot et al., 2003).Thus activity in dopamine neurons is linked to reward size and so such activity is linked to choices as choices follow reward.

An interesting FMRI study by McClure et al. (2003) found that people's stated preferences for Pepsi versus Coke were matched by responses in the ventromedial prefrontal cortex on tasting these drinks.

- **Dual System Approaches to decision making and neuroscience -**

The dual systems approach to decision making outlined above have also been supported by neuroscientific studies. When given the option of choosing between 100 rupees today or 200 rupees in a month, many people choose for the 100 rupees today. If the choice is between 100 rupees in a year and 200 rupees in a year and one month, the delayed option is frequently picked, despite the fact that the time difference between the two options is still one month, just as it was when 100 Rs was available immediately. The limbic system, which reflects System 1 activity and responds impulsively to immediate rewards, is thought to be the source of short-term impatience. The lateral prefrontal cortex, which reflects System 2 activity, controls the delayed reward choices. In an fMRI study, McClure et al. (2004) discovered that when participants chose delayed options, there was relatively more fronto-parietal activity (related with deliberative processing) and limbic system activation (associated with emotional processing) than when they chose immediate options.

- **Study of Emotions and neuroeconomics -**

By linking economic decision making to brain function, the emerging field of neuroeconomics has highlighted the overlap in the neural systems that mediate choice and other behaviors, including emotion. Like cognitive neuroscience before, the clean division between cognition (or reason) and

emotion in economic decision making is blurred when attempting to understand the neural circuitry mediating these classes of behaviors (Phelps, 2006)

In an fMRI study, Sanfey et al. (2003) discovered that accepting unfair offers was associated with relatively greater activation in the dorsolateral prefrontal cortex (related to controlled cognitive processing) and rejecting unfair offers was associated with relatively greater activation in the right anterior insula (related to negative emotions such as disgust).

6.5.3 Ageing brain and financial decision making?

Have you ever noticed that many investment companies target the retired people for their investment seminars where they explain that they will get high returns if they invest in their plan by showing them tempting offers? You must have. If you try to understand the reason behind that you will realize it is because older people ,despite having more experience, often make poor financial choices. Recent neuroscientific study are exploring on this area.

Older people, despite their years of knowledge, are more likely to make financial mistakes by exaggerating prospective benefits and downplaying potential risks. Older adults appear to be less concerned about potential financial losses than younger people.

Cognitive decline with ageing-

Understanding how financial systems work and having the mental acuity to locate and choose the best option are both required for making good financial decisions. 'Experience brings progress, but after a point, the accumulation of experience starts to be overshadowed by decrease in cognitive function,' according to Sumit et al. (2009).

This is consistent with our understanding of cognitive ageing, which shows that as we become older, we lose a number of cognitive abilities such as memory, analytical reasoning, and processing speed. Crystallized intelligence, a person's acquired knowledge about the world, is the only thing that remains constant or even increases.

Affective factor-

Affective processes have a role in decision-making, and it has been discovered that older people are generally more optimistic than younger ones, and are more prone to focus on the situation's possible benefits. This proclivity to emphasize on the good outcomes affects the decisions in elderly people.

If older individuals are aware that they are prone to focusing on the benefits or 'upsides' of their financial decisions, taking the time to consider the potential losses could help them avoid making costly judgments.

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6.6 SUMMARY

To summarize, this unit enumerated further theories of decision making with respect to multi-attribute alternatives. In the case of multi-attribute decision making, the burden of integrating multiple attributes into a single overall value measure leads to suboptimal but easy procedures like elimination-by-aspects and satisficing. Payne demonstrated the use of elimination-by-aspects, at least as a first stage in multi-attribute choice problems.

Gigerenzer (1993, 2007) emphasised the broad benefits of real-life heuristics like the recognition heuristic, which allow for good decision making with minimal effort (fast-and-frugal heuristics).

The popularity of fast-and-frugal heuristics, such as taking the first alternative thought of in a given situation, is further supported by studies of real-life decision making utilising the naturalistic decision making approach.

According to research into the brain underpinnings of decision-making and specifically in the area of financial decision making shows that how different neural processes are involved in the study of financial decision making

6.7 QUESTIONS

Q.1. What are the models of decision making to deal with multi-attribute alternatives? Explain normative as well as descriptive approaches.

Q.2.What are the relative roles of System 1 and System 2 processes in decision making?

Q.3. Explain the Gigerenzer's perspective towards heuristic and how it serve as adaptive toolbox? Explain how it is different from Kahneman's approach.

Q.4. Do neuroscience approaches increase our understanding of decision making? How?

Q.5 Write Short notes on-

A) Multi-Attribute Utility theory

B) Satisficing and Elimination by Aspects

C) Naturalistic decision making

D) Decision making in elderly people

E) Neuroeconomics

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7

REASONING - I

Unit Structure

7.0 OBJECTIVES

After reading this unit you will be able to understand –

1. What is reasoning?
2. What is Deductive Reasoning?
3. What is propositional reasoning?
4. What is meant by mental logic approaches?
5. What is syllogistic reasoning?
6. What are the various biases that influence logical reasoning?

7.1 INTRODUCTION

The great philosopher Aristotle said that all human beings are rational. They have the ability to reason. We are continuously using reasoning while making even routine daily decisions. We are evolutionary wired to use reasoning. It is crucial for our survival. Any error in our reasoning can adversely affect our relationships, our careers, and even our safety. People may use reasoning deliberately to solve certain puzzles or problems or they may use it at unconscious level, even while not being aware of it. For example, in the Silver Blaze story written by A.C. Doyle in 1892, Sherlock Holmes solves the mystery of disappearance of racehorse, named Silver Blaze, by using reasoning at conscious level. He argues that the horse was in the stable, guarded by a guard dog. If a stranger had entered

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the stable, the dog would have barked, but the dog did not bark. That indicates that the person who entered the stable and took away the horse was not a stranger. Using the reasoning like this, he came to the conclusion that that the theft of the racehorse was done by somebody from the known people and not by a stranger. The mystery was solved. On the other hand, when a mother observes the child lowering his face and stammering while answering her questions, she concludes that the child is guilty of doing something that he was not supposed to do. She has used reasoning at an unconscious level. When we hear the sound of water dripping, we conclude that the tap must be open and we go to check which tap is open. We use reasoning at unconscious level. Thuswe are genetically programmed to use reasoning in almost all of our decisions. Now, let us see what is reasoning.

"Reasoning is a stepwise thinking with a purpose or goal in mind" — Garrett.

2. "Reasoning is the term applied to highly purposeful, controlled and selective thinking"—Gates.

Reasoning is the cognitive process of deriving new information from old information.

"Reasoning is the word used to describe the mental recognition of cause and effect relationships, it may be the prediction of an event from an observed cause or the inference of a cause from an observed event"— Skinner.

Thus, reasoning is a highly specialized thinking which helps an individual to explore mentally the cause and effect relationship of an event or solution of a problem by adopting some well-organized systematic steps based on previous experience combined with present observation. There are two types of reasoning – Deductive and Inductive reasoning. In this unit, we will discuss deductive reasoning.

7.2 DEDUCTIVE REASONING

It is the ability to draw some logical conclusions from known information, that is known to be true. For example, All branches of psychology are interesting, Cognitive psychology is a branch of psychology. Therefore, cognitive psychology must be interesting.

Here one starts with already known or established generalized statement or principle and applies it to specific cases. For example,All human beings live in wateryou are a human being, therefore, you must be living in water.

Though the conclusion in above example seems to be logical but we know that it is not true. What does it show? It means that the truthfulness of the conclusion depends upon the first assumptions being true. The initial assumption is called premises, e.g., in above example, the statement 'all human beings live in water' is the premises or an assumption. The

truthfulness of conclusion depends upon this premises. The conclusion may be logical and yet not true if the premises is not true.

Deductive reasoning is further divided into two types –

1. Propositional reasoning
2. Syllogistic reasoning

7.2.1 Propositional Reasoning:

Propositional reasoning refers to a set of rules based on logic. These rules help in developing the arguments. These arguments consist of simple statements bound by simple logical relations. These logical relations are also called conditional rules, for example, these simple statements are connected to each other with words like and, or, not and if…then. Let us take an example, suppose the given statement is that 'if it is 7 p.m. Tina goes out to play'… it is 7 p.m. then it is very natural for people to conclude that Tina is out to play. On the other hand, if the statement is 'Tina is not out to play' it is very difficult for people to conclude that it is not 7 p.m.

Certain inference rules are developed by logicians to derive correct conclusions from patterns of propositions. For example,

a.) Modus ponens – The word modus ponens is derived from Latin language and it means 'mode of affirming'. According to this rule ' If p then q' and given p is true, it follows that q is true too. For example, if the premise is "If it is Monday(p), Tina goes to college(q)".Then given the information "It is Monday today(p is true) we can conclude therefore Tinahas gone to college(q is also true).

b.) Modus tollens – This Latin word means 'mode of denying'. According to this rule, 'if p then q' and given 'not q' therefore not-p follows. For example, if it is Monday, I go to college. I am not going to college today, therefore today is not Monday.

c.) Double negation – According to this rule not (not p) therefore p. For example, 'it is not not Monday, therefore , it is Monday".

The first two inference patterns ,viz., modus ponens and modus tollens have been often used in conditional (if..then) rules, but there are two significant fallacies or mistakes that people often make when engaging in such reasoning.

1. Affirming the consequent : Affirming the consequent is the first fallacy of conditional rule that uses the inference pattern of modus ponens in incorrect way. As according to modus ponens pattern, 'if p then q' , thereby assuming'q' means 'p' is true, is an error. For example, if it is Monday then Tina goes to college;Tina is going to college, therefore it is Monday. This inference is not correct, because the rule does not mean that Tina goes to college only on Monday.

2. Denying the antecedent: This is another fallacy of conditional rule that uses the inference pattern of modus tollens incorrectly. This involves using modus tollens pattern of, 'if p then q' to conclude 'not p' means 'not q' is true. For example, If it is Monday, Tina goes to college'. It is not Monday, therefore Tina is not going to college today. This argument is also not valid inference as the rule does not mean that Tina goes to college only on Mondays.

Above examples of 'if…then' conditional rules are called '*material implication*. There is another type of conditional rule that is known as *rule of equivalence or biconditional*. Biconditional rule states the rule as ' if and only if'. In other words, 'q if and only if p', that means p is true only if q is true (affirming the consequent) and 'not q' happens when 'not p'(denying the antecedent). For example, only and only if a closed figure is a triangle, then it has three sides and if it does not have three sides then it is not a triangle. Affirming the consequent and denying the antecedent are valid arguments if we follow the rule of equivalence but not valid if we follow the rule of material implication. There is a possibility of an error taking place if we misinterpret material implication as equivalence in conditional reasoning.

Psychologists carried out many research studies to find out how people perform on these four arguments, viz., modus ponens, modus tollens, affirming the consequent and denying the antecedent. These experiments were conducted by using both abstract material (e.g. , if there is an A then there is 1) as well as concrete materials (e.g., if it is Sunday then Tina eats non veg in lunch). Meta analysis of these studies indicated that people perform with almost 100 percent accuracy in the case of modus ponens, with 60 percent accuracy in case of modus tollens and about quarter of a time people correctly reject affirming the consequent and denying the antecedent fallacies.

Conditional inferences can be put in table form as shown in table 1 for better clarity

Table 1

Modus Ponens:	**Affirmation of the consequent**
If p, then q	If p, then q
P is true	q
_____	_____
Conclusion : q is true	Conclusion : p
Modus Tollens:	**Denial of the antecedents**
If p, then q	If p, then q
Not q	Not p
_____	_____
Conclusion: Not p	Conclusion: Not q

Suppression effects

Some psychologists believe that fallacies in conditional reasoning can be due to misinterpretation of the premises. For example, suppose a student is given the information that " if there is heavy rain, then water logging takes place in Mumbai". Student is now given the information that there has been water logging in Mumbai, he might draw the inference that " it must have rained heavily". But suppose if he is given additional information that water logging can take place due to high tide in the sea or due to clogged gutters, then he will not be so sure that water logging has taken place due to heavy rain.Rumain, Connell, and Braine (1983) in their study showed that when a possible alternative was explicitly presented to participants, the affirmation of consequent (e.g. if p then q ,q therefore p) and denial of the antecedent (e.g. if p then q, not p , therefore not q) are less likely to take place. They suggested that giving additional antecedents such as "if gutters are not clogged, there is no water logging" makes it clear that heavy rain is not the only thing required for water logging to take place and therefore equivalence interpretation is blocked and fallacies of affirming the consequent and denying the antecedent is suppressed.

Later on, Byrne (1989) found a similar effect on modus ponens and modus tollens when a possible disabler was mentioned. In other words, knowledge of additional background conditions suppresses inferences such as modus ponens and modus tollens. For a pair of conditionals that contain an additional condition (sometimes called an enabler), such as " if it rains heavily, water logging takes place in Mumbai; also if gutters are clogged, water logging takes place in Mumbai", the frequency of student making an inference drops drastically because now he is not sure why the water logging took place in Mumbai. For example, when a student is told " there is waterlogging in Mumbai" he no longer makes the modus ponens inference " therefore it rained heavily", and when a student is told that " there was no waterlogging in Mumbai" he does not make the modus tollens inference " therefore it did not rain heavily in Mumbai". These findings have come to be known as the suppression effect. The additional information or extra premises seems to form a conjunctive condition with the first premise or first information. For example, " If it rains heavily and if the gutters are clogged then water logging takes place in Mumbai". This indicates that surrounding context can affect interpretations and so influence reasoning.

Mental logic approaches

David Braine believed that people apply mental logic rules that they can apply

to solving reasoning problems. Braine et.al. (1991) explained three aspects of conditional reasoning –

1. A set of mental inference rules or schemas – it permits inferences when the schema conditions are met. These schemas match some rules of logic such as modus ponens but not modus tollens. These mental rules may also include fallacious inferences, such as denying the antecedent.

So the schemas may or may not match the formal inference rules. The schemas take the form of 'Premises Conclusion, an example of a disjunctive syllogism schema is: e.g. premises : p or q ; not p then conclusion: therefore q

Any two given statements represent p and q, if either p or q or both are true and not p is also true, it means q must be true. For example, "it is raining heavily or Rosy is shopping"; "it is not raining heavily"; therefore Rosy is shopping.

Brain et. al.(1984) suggested that there are 16 simple inference schemas on which people make less errors. If a given problem directly evokes a particular individual schema, it is considered as non- problematic by a person, but if it does not invoke individual schema, the person finds it problematic. For example, suppose the given information is "Either Mr. X will go to a restaurant or Mr. X will go for a movie" and the other piece of information given is "Mr. X will not go to a restaurant". This will evoke the disjunctive syllogism schema and by using that one can conclude that Mr. X will go for a movie. This is simple and the person making a decision will find it nonproblematic.

2. A reasoning programme that implements the schemas to construct the lines of reasoning

3. A pragmatic architecture in which reasoning is imbedded.

Braine et. al. (1984) proposed in their mental logic theory that people reason by applying mental rules in the form of schemas. An experiment was conducted to test Braine et.al.' s this proposal. In this experiment, participants were presented one line at a time (i.e. premises) at a predetermined speed on a computer monitor. After presenting all the premises, they were presented with a possible conclusion which the participants had to judge whether it is true or false. For example: The premises presented were -

7. There is an L or a W.

2. If there is an L then there's not an E.

3. If there is a W then there's not an E.

4. There is an E or an O.

Then they were asked in conclusion -

Is there is an O?

(Answer is 'Yes, there is an O'.)

This kind of task needs more than one kind of schemas to make a judgement. For example, the first three lines or premises in the above example indicated that there is not an E. Using this information, in the fourth line, one can infer from line four that there is an O. So one can say that the level of problem difficulty can be decided by the participants on

the basis of the length of the problem and the number of schemas required to solve that particular problem. In general, it has been found that Braine et al.'s mental logic theory proposing that people reason using a limited number of schemas, was well supported by their experiments.

Mental models

"Mental models are deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting. Very often, we are not consciously aware of our mental models or the effects they have on our behaviour." – Peter Senge

Mental models are made up of meaning, values, ideas, beliefs, concepts, premises, images, representations, previous experiences, symbols, language, assumptions, etc. mental models represent the meaning of connectives and quantifiers such as and, or, if, and also include such quantifiers as "most" and "few," and a variety of other sorts of constructions, such as spatial, temporal, and causal relations, and counterfactual conditionals. They are the thinking tools that you use to understand life, make decisions, and solve problems.

Mental model approach proposes that people tackle logical reasoning problems by forming mental representations of possible states of the world and draw inferences from those representations. Mental models, it is argued, offer economical forms of representation that appear psychologically plausible. In other words, each mental model represents a possibility. If the premises are true, there is a possibility of drawing a conclusion.

So, we can say that mental representations of possible states of the world is known as mental models. Mental models are also known as the model theory. A fundamental assumption of the theory is the principle of truth. Johnson-Laird (1999) stated that mental models help people reduce burden on working memory by only representing only what is true and not what is false. If mental models are not complete, they may lead to 'illusory inferences' that may be compelling, but invalid inferences. For example, Johnson-Laird (2006) conducted an experiment as follows –

Either Jane is kneeling by the fire and she is looking at the TV or elseMark is standing at the window and he is peering into the garden.Jane is kneeling by the fire.

Does it follow that Jane is looking at the TV?

Most people do say 'yes' to this question, but the inference is not valid; it is an example of an illusory inference.

Just because Jane is kneeling by the fire, it does not follow that she is looking at the TV; she may be or may not be. Johnson-Laird argued that the principle of truth leads people to form models in which the possibility of it being false is not represented and that is why the illusory inference takes place.

Johnson-Laird et al. (1992) also found that the number of mental models needed per problem depends upon the level of problem difficulty, i.e., difficult tasks require more models. They further reported that that modus ponens is easier than modus tollens for conditionals because modus ponens requires only one model while modus tollens requires three models. It was observed that exclusive disjunctions (i.e. '*p or q*, *but not both*') were harder than conditionals and that modus tollenswas easier with biconditionals (or equivalences) than with conditionals.

Obsessive-compulsive disorder, anxiety and depression are three examples of neuroses which are disorders of behaviour and feeling. Beck (1976, 1991) believed that they are due to faulty reasoning either from invalid inferences or from false beliefs and this is the basis of his cognitive-behavioural therapy. For example, a person with depression might make a conclusion without realizing that it is invalid,: 'If you're worthless then you fail at everything'; 'I failed my exam'; 'So, I am worthless'. On the other hand, Johnson-Laird et al. (2006) proposed that neuroses originated in overemotional reactions to situations (the hyper-emotion theory) and that reasoning errors were not a key factor in such mental illnesses. They argued that if anything, neurotic patients should reason better about material related to their disorder than controls, because the patients tended to be very preoccupied with their condition and mulled over material related to their condition very often.

Evaluation of mental models versus mental logic

One of the advantages of mental model theory is that at least in principle it can be refuted. But the disadvantage of mental model theory is that if a deduction depends upon many models then it violates its principal prediction. In case of mental logic theory, O'Brien et.al. (1994) showed that participants handled well even those tasks that required many models. For example, O'Brien et.al. (1994) conducted an experiment, where they propositioned that

If O or K or R or C then X

If E or F or G or H then Y

K F.

What follows?

100 per cent of participants answered correctly, 'X and Y', although the problem involves 58 mental models.

On response to this, Johnson-Laird et al. (1994) said that participants would not blindly generate models unnecessarily. They would realize that only a small part of the premises needs to be represented and that can be done with a manageable number of models. But the criticism against this argument is that one needs to add procedures to the model to enable participants to know when models are unnecessary and this makes the approach less straightforward than was originally thought of.

Both mental logic and mental models approaches successfully deal with propositional reasoning but only mental model approach easily applies to syllogistic reasoning.

7.2.2 Syllogistic Reasoning

So far, we have discussed propositional reasoning. Another type of deductive reasoning is categorical syllogisms. According to Merriam-Webster Dictionary syllogism is a kind of logical argument in which one proposition (the conclusion) is inferred from two or more others (the premises) of a certain form.

Timbreza (1992) defined syllogism as "an argumentation in which, from two known propositions that contain a common idea, and one at least of which is universal, a third proposition, different from the two propositions, follow with necessity".

CATEGORICAL SYLLOGISM is a deductive inference which consists of three categorical propositions, the first two which are premises and the third is the conclusion. It contains exactly three terms.

For example - All animals are mortals.

Every dog is an animal.

Therefore, every dog is mortal.

In this example, there are two assumptions about the category of things, "animals" and "dogs" and properties like being mortals. First two statements are the premises or assumptions and third statement is conclusion. As the third statement

(the conclusion) definitely follows necessarily from the first two (the premises) it is a *valid* syllogistic argument that leads to a true conclusion.

On the other hand, consider another example –

All Chimpanzees are mammals (premises)

All cows are mammals (premises)

Therefore all cows are Chimpanzees. (conclusion)

As you can see, in this example, the conclusion does not follow from the two true premises and has a invalid form of argument, so it is a invalid syllogistic argument. It is not possible for a valid syllogistic argument to have true premises and false conclusion. That is, the conclusion necessarily follows from the premises. An invalid deductive syllogism is one where if the premises are assumed true, it is possible for the conclusion to be false. That is, the conclusion does not necessarily follow from the premises.

Apart from validity, syllogism can be varied in various other forms such as –

Quantity wise – The quantifiers can be expressed in terms of all, none, some.

Quality wise - The premises and conclusion- may be negative or affirmative.

The terms – The terms used may be abstract or concrete. Example of abstract terms can be " All S are P" .Example of concrete terms can be "All dogs are mammals"

The premises and conclusion- may be negative or affirmative.

The propositions in the argument -may be empirically true or false.

Even the required responses can vary. For example, participants can be asked to generate valid inferences from given premises; to judge a possible conclusion as valid or not; or to select a valid conclusion from a list of alternatives.

Basic findings from syllogistic reasoning studies:

Wilkins (1928) showed that one of the problems with syllogism is that compared to concrete premises, inferences from abstract premises can lead to wrong conclusions. For example, in abstract form we may say

All Cs are Ms

All Ds are Ms

Therefore, all Ds are Cs

This argument in this abstract may be considered as valid argument though it is not valid. If we substitute abstract terms with concrete terms such as Cs as Chimpanzees and Ds as cows, then the conclusion as shown above will be all cows are chimpanzees, which is an invalid argument.

However, Wilkins (1928) suggested that sometimes even in case of concrete syllogisms, people accept invalid conclusions due to atmosphere effect.

The atmosphere effects:

Atmosphere effect is a tendency to draw conclusions in syllogisms that are over influenced by the form of the premises rather than the logic of the argument. The atmosphere effect is also known as 'global effect' created by the premises, and accounts for common errors in syllogistic reasoning. Woodworth and Sells (1935; Sells, 1936) definedatmosphere effect as the influence which the context, or tone, of a situation has upon the completion of a task. It was assumed that, if one does not understand, or does not usethe given logical relationships, the conclusion will be based upon the structural features of the syllogism, i.e., the quantifiers and qualifiers.

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Quantitative (all or some) and qualitative (affirmative or negative) attributes of premises can togetherproduce an "atmosphere" that induces a participant to either accept or reject a certain conclusion consistent with it.Woodworth and Sells (1935) proposed that if *both* premises involve 'all', people are disposed to accepting an 'all' conclusion. If anyonepremise involves 'some', people will be disposed to a 'some' conclusion. If any onepremise involves 'not', people are disposed to accept a 'not' conclusion. An invalid argument is often accepted by the participants, if the argument is presented in abstract form.

Atmosphere versus conversion errors (illicit conversion) and probabilistic inference:

Chapman and Chapman (1959) presented an alternative to atmosphere effect hypothesis. According to thempeople apply heuristicsknown as 'conversion' and 'probabilistic inference'which are not appropriate. In their experiment, they gave participants problems such as

Some Ls are Ks

Some Ks are Ms

Therefore, (1) No Ms are Ls, (2) Some Ms are Ls, (3) Some Ms are not Ls, (4) None of these, (5) All Ms are Ls.

The correct conclusion to above problem is (4) 'None of these'. Participants tended to be wrong on such items and the kind of error that they made depended on the form of syllogism. When they presented different types of syllogism, the type of error that participants committed was determined by the atmosphere effect. However, participants failed on the following type of syllogism –

(A)

Some X are Y

No Y are Z

and

(B)

Some X are not Y

No Y are Z.

The right response for both A and B (on atmosphere) was 'Some Z are not X'; but most of the participants chose 'No Z are X', especially on (A) problem. In case of B problem, they were evenly split between the universal and the particular conclusions on (B).Chapmans said that results of their experiment can be explained further by two reasoning errors called 'conversion' and 'probabilistic inference'.

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Conversion errors:

There are two types of conversion errors that will be described first in abstract terms and then in concrete terms. First is the assumption in abstract form that–

(1) from 'All X are Y' that 'All Y are X' and

(2) that 'Some As are not Bs' implies

'Some Bs are not As'.

In concrete form, it will be -

'All women are human', but it does not imply that 'All humans are women'. Similarly, saying 'Some humans are not politicians' does not imply that 'Some politicians are not humans'.

Chapmans said that people tend to make conversions unless they have information to the contrary (which they do not have with abstract material).

Probabilistic inference:

Probabilistic inference refers to 'plausible reasoning' that is not valid in deductive logic. For example , suppose it is said

'Some cloudy days are wet', (premises)

'Some wet days are unpleasant', (premises)

'Some cloudy days are unpleasant'(conclusion)

In this example, the conclusion may be true or may not be true. It does not necessarily follow from the premises, even if the premises are true. The Chapmans said that these two types of errors explained their results much better than the atmosphere effect.

Later on ,Begg and Denny(1969), Sells (1936) and Chapman & Chapman (1959) re-examined the atmosphere effect vs. conversion error and found that atmosphere predictions were more frequently found to be true than the conversion and probabilistic inference predictions.

However, Wason and Johnson-Laird (1972) concluded from their study that atmosphere hypothesis cannot completely explain syllogistic reasoning. Even Wilkins's (1928) too reported that atmosphere effect is not so strong with familiar or concrete material as it is with abstract or unfamiliar material.

7.3 HENLE ON 'RATIONALITY'

Henle(1962) was of the opinion that theatmosphere hypothesis, probabilistic inference and illicit conversion do not fully explain our rationality. Henle argued that many samples of thinking that appear to be

the examples of illogical thinking actually tacitly ignore some of the given premises, ignore the misrepresentation of some the other premises, and include additional premises. In general, people make rational inferences depending upon how they interpret the premises. To support her point of view, For example , Henle gave the following problem participants of experiment and asked them to assess the validity of this argument, as well as give reasons for their answers.

It's important to talk about things that are in our minds.We spend so much of our time in the kitchen that household problems are in our minds.

Therefore, it's important to talk about household problems.

She found that some of her students did not look at the task as an exercise in pure logic. They did not differentiate between logical validity and factualtruth. They said that "it is not important to talk about things in our minds unless they worry us." Many of them interpreted the premises or conclusion and this led to change in intended meaning. Some of them completely ignored the premises and said " I don't think of household problems so it is not important for me to talk about them".

At times, participants added a totally new premises that was not given to them originally. For example, " It is only important to talk about the things that really worry us a lot and household problems don't; so it is not important to talk about them".

On the basis of such observations Henle (1962) said that the reason for subjects seemingly giving invalid conclusions or failing to see the fallacy, can be that they have worked with material which is different from the intended material or they may have performed the task in a different manner than what was intended. So, if we take into account the way an individual actually understood the material and the task to be performed, then his conclusion may not appear to be invalid and his reasoning may not appear to be a faulty reasoning. This shows that laws of logic can be detected from their thinking process itself.

Henle emphasized that different participants can interpret tasks, materials and goals in different ways. If we pay attention to different possible interpretations of an argument, then it is easy to understand the behaviour of people and conclude that they have followed the logical reasoning but that reasoning is different from what experimenter had originally intended it to be.

Ceraso and Provitera (1971) compared the interpretations of traditional syllogism statements and syllogism premises having very clear interpretations. For example, one group of participants were given the statement 'Some of the As (but not all) are Bs, but all of the Bs are As' (syllogism statements with clear interpretation).

Another group were given the traditional syllogism statements such as "Some A's are Bs". The results showed that participants who were given

the clarified premises performed much better than those who were given the traditional syllogism premises.

Culture and logic:

In 1971, Luria conducted a study on non-literate peasants in Soviet Central Asia and in the same year Cole conducted a study on non-literate Kpelle adults in rural Liberia to understand their logical thinking to a reasoning problem. In Luria's study, participants did not consider the given task as merely an exercise having no contextualized logic. They considered the given exercise as task that requires strong contextualized real world information. For example, the exercise given to them was

In the far North all bears are white.

Novaya Zembla is in the far North.

What colour are the bears there?

Participants typically responded to this by saying, "But I don't know what kind of bears are there. I have not been there and I don't know."

Cole (1971) gave the exercise such as "At one time Spider went to a feast. He was told to answer this question before he could eat any of the food. The question is: Spider and black deer always eat together. Spider is eating. Is black deer eating?"

Initially, participant responded by saying that " I was not there, how can I answer that question?" Later on, he said the black deer was eating grass but he gave a non-logical reason for it.

Both these studies indicated that when someone gives a correct answer to a reasoning problem, it does not mean the answer was deduced by applying rules of logic.

Greenfield (2005) said that such non logical reasoning is influenced by the cultural mindset of a person. Broadly, cultures can be categorized as collectivist culture and individualistic culture. The collectivist mindset represents the typical rural preindustrial societies where majority of the people did not have exposure to formal education. This type of mindset emphasizes the use of practical and contextualized knowledge in real social settings. On the other hand, the individualistic mindset is predominant in industrialized, urban and formally educated populations. People having individualistic mindset are the ones who were exposed to formal education. They can recognize and apply abstract knowledge of rules and principles. For example, they can use the abstract principles and rules of science and mathematics.They in fact value such rules.

Triandis (1989) believed that approximately 70percent of world's population belongs to collectivist mindset but Greenfield (2005) believed that many people have both the tendencies but in varying proportion. Some people have more of collectivist mindset and less of individualistic mindset and some other people have more of individualistic mindset and

less of collectivist mindset. But they have both types of mindsets. Which type of mindset will be more or less depends upon the opportunities that a person gets in life. It also depends upon how religious a person is, as all religions emphasize on collectivistic values. Garner et.al. (2005) proposed that by using suitable priming methods, less dominant mindset can be brought forth in dominance. For example, individualism can be brought forth in Asians and collectivism can be brought forth in Americans.

Mental-model approaches to syllogisms:

Johnson et.al. (1975) showed how figure of the syllogism can lead to bias in conclusion. They called it as 'figure bias'. Figure bias can be defined as the effect of figure on preferred conclusions. Now the question in your mind will be what is figure in syllogism.

Syllogism has three terms – A,B, and C. The way these three terms are laid out or paired is called figure. There are four possible syllogistic figures - A-B, B-C; B-A, B-C; A-B, C-B; B-A, C-B. These layouts or pairs determine which valid conclusions are preferred by a person. Let us put it in concrete example. Suppose the premises are –

'Some of the parents are scientists;

all of the scientists are drivers;

therefore ……?'

In this syllogism, topicterm is not specified. We do not know whether this syllogism is about parents or about drivers. So, we may draw a conclusion that 'some of the parents are drivers. An equally valid but alternative conclusion can be- 'some of the drivers are parents'. Now suppose, the premises are

'Some of the scientists are parents;

all of the drivers are scientists'

The conclusion would be "Some of the drivers are parents" and there can be another alternative but valid conclusion that 'Some of the parents are drivers.

Johnson et.al.found that using premises of the form 'A-B;'B-C' always produced a biased conclusion in the form of 'A-C' even when 'C-A' conclusions were valid. This tendency to draw conclusions in the form of A-C is called *figure bias effect*. As mentioned before, figure bias effect refers to the effect of figure on preferred conclusions.

Johnson – Laird (1982,1983) believed that people first construct mental models to interpret the premises. If the person draws a conclusion from the given premises but makes an alternative model that is consistent with the given premises but does not have same conclusion as the previous one that the person thought of, it will be considered the case of effective reasoning.

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It was noticed by them that the atmosphere hypothesis, conversion and probabilistic inference hypothesis do not predict the figure bias effect. So, Johnson-Laird and Steedman(1978), came up with the mental models theory. This theory has 4 stages. They are -

(1) interpretation of premises;

(2) initial heuristic combination of the representations of the two premises;

(3) formulation of a conclusion corresponding to the combination of premises;

(4) a logical test (or series of tests) of the initial heuristic combination, which may lead to the conclusion being modified or abandoned.

This theory differs from the previous mentioned theories in terms of the last testing stage. This last stage can lead to a changed combination of information in the premises which in turn may be tested again.

Johnson-Laird and Steedman explained the theory in the form of a computer program and its performance vs. human performance. In their experiment they used 64 problems. It was expected that some syllogisms would not lead to any modifications while others would lead to modified conclusions after testing. Where it was expected that premises will not lead to any modifications after testing did meet the expectation and were found to be 80.4 percent correct, while in other syllogisms 46.5 percent were found to be correct.

It was believed that figure bias takes place when the information is processed in short term memory. Johnson-Laird and Bara (1984) conducted an experiment to test this belief and found that figure bias did take place even when the participants were exposed to syllogism for a brief period of just 10 seconds. With such short exposure to syllogism, participants found it difficult to make combinations of premises in certain figures (such as B-A, B-C, in which required reordering of terms in one of the premises in order to integrate premises) and this led to high rate of (incorrect) conclusions that 'no conclusion can be drawn'. Johnson-Laird (1983, p. 104) reports data from studies which found that the rate of drawing correct conclusions declined sharply as the number of possible combined models increased from one to three because load on working memory increased. Gilhooly (2005) also supported this view that difficult syllogisms put heavy load on working memory, impairing its performance.

Evaluation of Mental Models Theory:

1. First term as the topic of the argument - Wetherick and Gilhooly (1990) and Ford (1995) have indicated other possible explanations of figure bias. Wetherick and Gilhooly believed that figure bias takes place because people have a tendency to pick the first term as the topic of the argument. For example, if the premises presented is 'All the scientists are drivers' and 'All the drivers are golfers' it is natural to take 'Scientists' to be the topic here and to draw a conclusion about scientists, 'All the

scientists are golfers'. If the premises were 'Some drivers are golfers' and 'All the scientists are golfers' a conclusion in which 'drivers' was the topic ('Some drivers are scientists') would be more natural.

2. The mental models theory assumes that all participants approach the task in the same way and the theory does not provide any explicit mechanisms of change or improvement. But in reality, in any large sample of participants, there are bound to be individual differences. Some may get most syllogisms correct, some others may be at guessing level and the remainder may show the typical variations in item difficulty.

Galotti et al. (1986) found in their experiment that participants who had no training in formal logic but were bunched up as 'good resoners' either used or quickly developed short-cut rules that helped them in avoiding laborious explorations of multiple models. For example, better reasoners used the rules that two 'some' premises could only yield no valid conclusion and similarly that two negative premises must give no valid conclusion.

Belief bias and dual system theory

Studies have indicated that arguments can differ in validity or truthfulness of the conclusions. The problem of truthfulness or believability generally does not arise when argument has abstract material. Basically, no participant has prior belief about whether or not 'All As are Cs'. But when concrete material is picked up from real life materials, prior beliefs do influence the judgement about the validity of the presented argument. For example, Kahneman(2011) demonstrated an example of *belief bias*. He presented a syllogism to his subjects –

All roses are flowers

Some flowers fade quickly

Therefore, some roses fade quickly.

Majority of the people will consider it to be valid argument because conclusion is true in real life. But if we ignore the context and just look at the premises presented to us, the conclusion does not follow logically from the premises. There is an alternative possibility that may be there are no roses in the set of flowers that fade quickly.

7.4 SUMMARY

In this unit, we started with what is reasoning and why it is important. Reasoning was defined as stepwise thinking with a purpose or goal in mind. It is a cognitive process of deriving new information from old information. Next it was emphasized that there are two types of reasoning – deductive and inductive. In this unit we have discussed deductive reasoning and in next unit we will discuss inductive reasoning. It was emphasized that deductive reasoning means applying certain logical rules

to given information to draw valid conclusions. Deductive reasoning is also of two types – propositional reasoning and syllogistic reasoning.

Propositional reasoning helps us to develop arguments based on certain rules of logic. Drawing conclusions from given statements or premises is known as drawing inferences. Some of the inference rules are modus ponens, modus tollens, and double negation. Modus ponens and modus tollens are used mainly in conditional problems where the premises are in the form of if…then. However, these rules suffer from two fallacies – affirming the consequent and denying the antecedent. Another fallacy of conditional reasoning is suppression effect. This takes place due to misrepresentation of the premises. It is found that knowledge of additional background conditions suppresses inferences such as modus ponens and modus tollens.

Braine et. al. (1984) proposed in their mental logic theory, in which they emphasized that people use a set of mental inference or schemas, a reasoning programme that implements the schemas to construct the lines of reasoning and a pragmatic architecture in which reasoning is imbedded.

Mental models are the thinking tools that you use to understand life, make decisions, and solve problems. They aremade up of meaning, values, ideas, beliefs, concepts, premises, images, representations, previous experiences, symbols, language, assumptions, etc. mental models represent the meaning of connectives and quantifiers such as and, or, if, and also include such quantifiers as “most” and “few,” and a variety of other sorts of constructions. Mental models are also known as the model theory. If mental models are not complete, they may lead to ‘illusory inferences’ that may be compelling, but invalid inferences.

Another type of deductive reasoning is categorical syllogisms. Syllogism is an argumentation in which, from two known propositions that contain a common idea, and one at least of which is universal, a third proposition, different from the two propositions, follow with necessity.

Atmosphere effect is a tendency to draw conclusions in syllogisms that are over influenced by the form of the premises rather than the logic of the argument. Quantitative (all or some) and qualitative (affirmative or negative) attributes of premises can combinedly produce an "atmosphere" that induces a participant to either accept or reject a certain conclusion consistent with it.

When people apply heuristics which are not appropriate , it is known as ‘conversion’ and ‘probabilistic inference’.Chapmans said that people tend to make conversions unless they have information to the contrary .Probabilistic inference refers to ‘plausible reasoning’ that is not valid in deductive logic. the conclusion may be true or may not be true. It does not necessarily follow from the premises, even if the premises are true. While talking about rationality, Henle (1962) said that the reason for subjects seemingly giving invalid conclusions or failing to see the fallacy, can be that they have worked with material which is different from the intended material or they may have performed the task in a different manner than

what was intended. Studies indicated that when someone gives a correct answer to a reasoning problem, it does not mean the answer was deduced by applying rules of logic.

Mental Model approach to syllogism has 4 stages - (1) interpretation of premises;

(2) initial heuristic combination of the representations of the two premises;

(3) formulation of a conclusion corresponding to the combination of premises;

(4) a logical test (or series of tests) of the initial heuristic combination, which may lead to the conclusion being modified or abandoned.

Belief bias generally does not take place when the premises are in abstract form but takes place when premises are in concrete form.

7.5 QUESTIONS:

1. Define propositional reasoning. Discuss in detail various inference rules developed by logicians to derive proper conclusions from patterns of propositions?
2. Elaborate on mental logic approach and evaluate mental models.
3. Explain the concept of syllogistic reasoning and elaborate on basic findings from syllogistic reasoning studies.
4. Write a short note on –
   a) suppression effect,
   b) the atmosphere effect,
   c) conversion errors,
   d) probabilistic inference,
   e) rationality,
   f) culture and logic.

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8

REASONING - II

Unit Structure

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8.0 OBJECTIVES

After studying this chapter, students will be able to:

- Learn is inductive reasoning and where it is used
- Understand different researches conducted to explore inductive reasoning

8.1 INTRODUCTION

In previous unit we learnt about deductive reasoning, in which inferences or conclusions are drawn on the basis of logical rules and the conclusions are true if the premises are true. In inductive reasoning, the conclusion need not follow from given premises. According to APA dictionary,

"inductive reasoning is a form of reasoning in which inferences and general principles are drawn from specific observations and cases."

It is the base of developing hypotheses(expected relationships between variables) and verifying their truthfulness.

Inductivereasoning has two tasks –

a.) Hypothesis testing - assessing hypotheses for truth/falsity against data. The hypotheses cannot be conclusively proved but they can be disproved. Inductive reasoning is inherently uncertain. In this form of reasoning we cannot conclusively prove the hypothesis true, we can only say in degrees to which, given the premises, the conclusion is credible according to some theory of evidence. Instead of being valid or invalid, inductive arguments are either strong or weak, which describes how probable it is that the conclusion is true.

Hypothetico-Deductive Method: This is one of the most prevalent method of testing the hypothesis. In this method, first conclusions are drawn from the premises and then the truthfulness of those conclusions are verified against the data.

b.) Hypothesis generation – This refers to deriving possible hypotheses from data for later testing, that is, a person can get data from obtained observations and aim to make a generalization supported by the evidence. Such hypotheses need to be tested and may not lead to absolutely true conclusions.

8.2 INDUCTIVE REASONING: TESTING HYPOTHESES - THE FOUR-CARD SELECTION TASK

Wason (1966,1968) tested hypothetico-deductive reasoning by using the four card selection task also known as Wason card task.This task is used to test the truthfulness or falsification of hypotheses. To use this method, four cards are shown to a participant. Each card has a letter on one side and a number on the other side. The participant is asked to identify the card which need to be turned over to test the statement, " If a card has a vowel on one side, then it has an even number on the other side.". It is based on conditional reasoning and to complete this task, there can be four possibilities –

a.) Abstract version: Each card has the letter A or B on one side and the number 1 or 2 on the other side. Rule: If a card has a '1' on one side it has an 'A' on the other side.

b.) Concrete version: Each card represents a journey and has a destination on one side and a means of transport on the other side. Rule: If a card has a 'Churchgate' written on one side it has a 'Train' written on the other side.

c.) *Drinking rule*: Each card has a person's age on one side and what he is drinking in a bar on the other side. Rule: If someone is drinking alcohol they must be of age 18 or over.

d.) *Negative abstract version*: Each card has the letter A or B on one side and the number 1 or 2 on the other side. Rule: If a card has a '1' on one side it does not have a 'B' on the other side.

These proposed rules or hypotheses can never be absolutely verified, but can be falsified. Since you can verify only a limited number of instances, there is always a possibility of encountering an instance that does not follow the rule. For example, if we hypothesize that "Indians like panipuri", we may verify this with several Indians ; however there is always a possibility of encountering an Indian who does not like panipuri. So, it is not possible to absolutely verify the rule, but if a person does not like panipuri, it is easy to falsify the rule. This is the general characteristic of universal hypotheses. Philosopher Karl Popper (1959) has emphasized on the logic of falsifying hypotheses.

In vase of above task, for examplethe rule, 'If vowel on one side, then even number on the other side', can be tested by using the cards showing 'E' and '7' because they could falsify the rule(if E does not have an even number on the other side and if 7 has a vowel on the other side). The '4' and the 'K' cards may be left unturned since whatever is on their other sides would be consistent with given rule.

8.2.1Basic results

While testing the conditional rule 'if p then q' there can be four possibilities as shown in following boxes -

P, q	P, not q	*not p, q*	*not p, not q*

In these four possibilities only the second one 'p and not q' is not in consonance with the rule, rest of them are in accordance to the rule. It has been observed in studies that when participants are asked to test the given conditional rule 'if p then q' on a four card task, they very frequently choose the first option, i.e., 'p, q' instead of 'p, not q'. The reason is that people tend to be biased towards verification or confirmation, so they tend to choose potentially confirming card (p, q) and ignore the potentially falsifying card (p, not q). In other words, a card having 'p' on face may have 'q' on the reverse side (potentially confirming) or it may have 'not q' which is potentially falsifying. They understand that if a card having 'not q' on face has 'p' on the reverse side will falsify the rule and yet they tend to choose a card with 'p' on face side.

8.2.2 Procedural variations

Wason et.al. (1969) tried to find out the procedural variables that may be making the task difficult for the participants. In one study , they presented

strictly 'Vowel – even number' cards as shown below. These cards had lots of possible combinations but that did not create any confusion in the minds of the participants.

A	E	4	7

"If a card has a vowel on one side, then it must have an even number on the other side "Which cards must be turned over to test this rule?

Later,Wason and Johnson-Laird (1970) thought that may be participants were confused with the expression ' the other side of the card' in the instructions and might have interpreted it to mean 'the side face downward'. So, they conducted another experiment, in which they presented cards that had all the information on one side and used masks to hide the appropriate part of the card. The results were no different from the previous experiment. So they conducted another experiment in which the instructions were changed and participants were asked to pick up a card which 'could break the rule'. Still there was no change in the performance of the participants.

However, when Wason and Shapiro (1971) conducted another research by using concrete material on the cards instead of abstract material, they found the results were different from the previous experiments. In the experiment with concrete material, participants were given information about four journeys. Cards carried the names of the destination towns, on one side, and the mode of the transport on the other side. For example –

Manchester	Car	Train	Leeds

In this experiment they specified the rule that 'Every time I go to Manchester, I go by train'. To get right answer, the participants needed to turn over Manchester and Car card, and most of them got it right. Later onGilhooly and Falconer (1974) also got similar results when they replicated the study.

Encouraged by these results, Johnson-Laird et al. (1972) conducted another experiment. In this experiment, they made the task not only concrete but also life like. They asked the participants to imagine that they work in the Post Office and their job is to sort the letters. They have to find out whether the following rule had been broken.

'If a letter is sealed, then it has a 5 penny stamp on it.'

They were familiar with this rule as it was in practice in real life too in UK. Four different envelops were given to them . The four types of envelopes were either sealed or not sealed and had either 4 penny stamp or 5 penny stamp.

Sealed	Not sealed	4 penny stamp	5 penny stamp

Apart from this concrete condition, they simultaneously presented an abstract condition task too. In abstract condition, the rule was 'If an envelope has a D on one side, then it has a 5 on the other side.'

A	D	5	7

Surprisingly, participants performed better on selection tasks where concrete and realistic material was used rather than on abstract material selection tasks.

8.2.3 Interpretation factors

Many psychologists argued that Wason's four card task has lot of ambiguity. It is possible that participants make interpretations that are different from what was intended but while giving reasons for their interpretation they give correct reasons.

For example, Smalley(1974) gave three different sources of ambiguity –

1. Is the rule 'reversible' or not? i.e. does p – q also mean q – p or not?

2. Does the rule refer to both sides of the card or just to the showing side?

3. Is the task one of verification, falsification or both?

These ambiguities can lead to 12 different possible interpretations. In Smalley's study, such different interpretations did occur and the participants' choices were consistent with their interpretations.

In another study**,** Bracewell (1974) gave a 'clarified' statement of the task and the rule given was

'If either the showing face or the underside face of the card has a J on it then 2 is on the remaining face. This hypothesis should not be interpreted to mean that 2 only occurs with J.Please indicate the card or cards it is necessary to examine in order to see if the above hypothesis is false.'

The results of this study showed that success rate with clarified instructions was much higher than the other studies where standard instructions were used. It was further argued that realistic concrete material too gives better results than abstract material because participants can see the illogical aspect of interpreting a reverse rule. For example, if the rule says, 'If I go to London, I go by car', it is very unlikely that people will interpret it in reverse order, 'If I go by car, I go to London". In

case of abstract rule, when participants are thinking of the right answer to a task, they will not use such plausible checks while reversing the abstract rule. In abstract rule p and q appears to be logical if it is reversed to q and p. For the same reason, participants were found to perform better on drinking rule task mentioned above.

8.2.4 Matching bias

Matching bias in the four-card task refers to choosing the card mentioned in the rule. Evans(1984) pointed out that when people have to select a card in abstract version, they tend to show 'matching bias'. That means they simply select the cards that show the symbols mentioned in the rule or we can say that responses match the input and no 'deeper' processing takes place. For example, when a negative form of the rule was used such as " If B on one side, there will not be 3 on the other' side, the success rate was very high. Most of the participants chose card 'B' and '3" which was the correct potentially falsifying choice pattern. This occurred due to fact the participants simply matched the information and did not show any specific insight into the logic of the task. The same participants made errors consistent with matching hypothesis when tested with positive version of the rule.

8.2.5 Memory-Cueing (Availability) Accounts

Griggs, R.A., & Cox, J.R. (1982) proposed that performance on the selection task is facilitated when the presentation of the task allows the participant to recall past experience with the content of the problem, the relationship expressed and the counter example to the rule monitoring the relationship. They conducted an experiment having a rule determining the legal drinking age in Florida. Participants were asked to consider themselves as police officers and their task was to enforce the rule, 'If a person is drinking beer, then the person must be over 19". The experiment followed the four card task with age on one side and drink on the other.

Beer	Coke	22 years	16 years

The task was to indicate the card that definitely needed to be turned over to determine whether the rule was being violated. The results showed that 75 percent participants made right choices. This supported the memory-cueing proposition.

8.2.6 Pragmatic Reasoning Schemas

So far we have discussed how memory cueing influences the performance on conditional rule testing tasks, especially on tasks that involve abstract conditions. Cheng &Holyoak (1985) proposed another possible factor that may influence the performance and that is pragmatic reasoning schemas.

They argued that people solve the real-world versions of the task using pragmatic reasoning schemas which are not so abstract. They suggested that though there are many types of schemas, the crux of four card problem is the 'permission schema'. Permission schema basically means 'If a person satisfies condition A, they have permission to carry out action B'. They believed that if permission schema is activated, it will improve performance in a four-card task.

For example, in the abstract problem, participants were not encouraged to activate permission schemas and therefore their performance was comparatively poorer than in the drinking problem, where people were encouraged to activate permission schemas. In drinking problem, the participants could think about whether people drinking beer had permission to do so or not.

Cheng and Holyoak (1985) conducted a study to examine the effect of permission schema. The participantswere instructed to imagine that they are an immigration officer at the International Airport and they have to check the documents of the passengers. In those documents, they were asked to check a sheet called Form H. One side of the form indicates the whether the passenger is entering the country or in transit and the other side of the form was a list of tropical diseases. They were instructed that 'If the form says "ENTERING" on one side, then the other side includes Cholera among the list of diseases'. Which of the following forms would you have to turn over to check? Indicate only those that you need to check to be sure.There were 4 possibilities based on p, q, not-p, and not-q.

Half of the participants were given the explanation for 'cholera' rule by saying that one side of the form indicates whether the passenger is entering the country and the other side of the form lists inoculations the travelers had received in the past 6 months. You have to make sure that if the form says "entering" on one side, that the other side includes cholera among the list of diseases. This is to ensure that the entering passengers are protected against the disease. It was expected that this explanation would invoke the 'permission schema' and participants will show a remarkable improvement in their performance when the rationale for the rule is given. Results supported this assumption. In abstract version only 56 percent gave correct answers while in permission schema condition and rationale given for that 91 percent participants gave correct answer.

This result was not consistent with the memory-cueing explanation since participants did not have relevant memories; nor was it consistent with the syntactic rule view, since the logical structure of the task is not affected by the rationale. The result was consistent with the pragmatic reasoning schema approach.

8.2.7 Social Contract Theory

Cosmides (1989) has been conducting research to understand reasoning from evolutionary perspective. She proposed that people have many innate special purpose mechanisms to handle salient problems. Especially the

problems that are very important for the survival of many generations. She concluded from her research that social contract cannot evolve or sustain in a social group unless the cognitive machinery of the participants allows a potential cooperator to detect individuals who cheat, so that they can be excluded from future interactions in which they would exploit cooperators. A cheater can be defined as an individual who accepts a benefit without satisfying the requirements that provision of that benefit was made contingent upon. For example, suppose a person who has agreed to contribute equally to a group assignment is found to enjoy the credits of doing the group project without working for it at all will be called a cheat. Cosmides proposed that humans have evolved so that they possess a 'cheat detecting algorithm' to detect such possible cases of cheating.

Now the question arises, how this evolutionary cognitive concept fit in our selection theory. Cosmides believed that when four card task with thematic material fits the social contract pattern, it produces high rate of correct(falsifying) answers. Griggs and Cox (1982) also demonstrated the support for social contract theory. They showed that a cost has to be paid in terms of waiting to beold enough or in terms of money before a benefit can be taken, i.e., drinking beer.

Later on, in 1989, Cosmides compared availability and pragmatic schema approach with social contract theory.

Social contract and Availability Approach –
Availability theory assumes that participants are influenced by their familiarity with the content of a rule. The more exposures a subject has had, say for example, to P and Q, the stronger that association will be and the more easily P and Q will come to his mind and will be "available" as a response

Availability predicts a low percentage of logically falsifying, P & not-Q' , responses for all unfamiliar rules, whether they are social contracts or not, and does not predict the response 'not-P & Q' under any circumstance. Social contract theory predicts a high percentage of 'P & not-Qt responses to "standard" social contracts, and a high percentage of 'not-P & Q' responses to "switched" social contracts -- no matter how unfamiliar the social contracts are.

Cosmides made problems which had unfamiliar social contracts, unfamiliar descriptive rules, familiar descriptive rules and abstract rules. For example, in case of unfamiliar social contract, she made the following Cassava rule –

Cassava rule:

If a man eats cassava root, then he must have a tattoo on his face.

The cassava rule was explained in a context story as a social contract in a tribe called the Kaluame. The cassava root is a powerful aphrodisiac that is given only to married men and only married men are tattooed. The elders have established the cassava rule because they strongly disapprove

of sexual relations between unmarried people. Many unmarried men, however, are tempted to cheat. Participants were asked to ensure this rule.

They were presented with four cardsindicating information about four young Kaluame men. Each card represents one man. One side of the card tells which food a man is eating, and the other side of the card tells whether or not the man has a tattoo on his face. Indicate only the card(s) you definitely need to turn over to see if any of these Kaluame men violate the rule.

P **Not -Q** **Not -P** **Q**

Since cheating means taking the benefit P and not meeting the requirement Q, subjects should select P & not-Q. In fact, about 70% of Cosmides' subjects selected P & not-Q in this social contract problem.

In case of familiar description, she made a "transportation rule".

Transportation rule:"If a person goes into Boston, then he takes the subway." The places and means of transport were familiar to the participants. The four cards had information about where a person went and how the person got there.

The abstract version was similar to Wason's original problem. In all cases a 'detective' type of set was induced to encourage participants to look for violations of the rules. The transportation rule was not a social contract. There were no two people who engaged in a contract, nor was P a benefit for one person and a cost for the other, nor did this hold for Q. Therefore, social contract theory was not applicablein this problem.

Overall results of these experiments indicated that there was a high rate of falsifying(p and not q) in the unfamiliar social contract condition (70%),a low rate of falsifying with unfamiliar descriptive problems (23%)a medium rate of falsifying with familiar descriptive problems (42%).

Cosmides (1989) further tested social contract theory with 'switched' social Contracts.The switched version of Cassava root rule states 'If a man has a tattoo on his face then he eats cassava root'

Participants were tested with the switched social contract, unfamiliar descriptive rules, familiar descriptive rules and abstract descriptive rules. The results indicated a high rate of the not-p and q choices for the switched social contract (70 per cent) with a near zero rate of such responses in the other conditions. This further supported the social contract theory.

Social contract and Pragmatic schema approach

Cheng &Holyoak (1985) proposed that people reason using pragmatic reasoning schemas which are abstract knowledge structures induced from ordinary life experiences such as "permission," "causation," etc. Cosmides said that though all social contracts are 'permissions' not all permissions are social contracts, since social contracts always involve costs and benefits while permissions as a class do not always do so. Permission rules are beneficial only when they include costs and benefits. In other words, permission rules need to be in the form of social contract to be effective. To prove her point of view, Cosmides conducted an experiment in which the same rules were framed by means of background stories as either social contracts (in which the actions were taking benefits and the preconditions were costs to be met) or as permissions where the same actions and preconditions were without costs or benefits to the individuals. The results showed that falsifying choices (p and not-q) were more frequent for the social contract version than for the permission version (80 per cent vs. 45 per cent). Thus, it has been noted that Cosmides's evolutionary approach identifies rules that reliably produce response patterns that match falsification choices (p and not-q) or if switched will produce choices unlikely to occur in the standard abstract version (not-p and q).

Studies conducted on social contract theory and pragmatic reasoning schema approach have shown the effectiveness of deontic rules on four card tasks. Deontic rules refer to obligations involving terms like should, ought, must, etc. The very fact that people's selection task choices are as per deontic rules included in the social contract theory indicates that either human brains got hardwired to special purpose mechanisms due to evolutionary pressure or they acquire such practical knowledge in the normal development process through general purpose learning mechanisms.

8.2.8 The selection task as optimal data selection

In the beginning, Wason's studies were inspired by Popper's (1959) notion that seeking falsification was the rational way to test scientific hypotheses or any causal or indicative hypothesis. However, studies have shown that very few people on their own instantly adopt a falsifying approach to the standard abstract selection task. Researchers have been attributing people's disinclination to falsification as a sign of imperfect rationality.

Oaksford and Chater (1994) rejected logicism and considered falsification philosophy of science as an outdated model and gave an alternative normative approach. This approach used a statistical rule called *Bayes's theorem.* Bayesian model gives a rational analysis of the selection task that fits well with people's performance on both abstract and thematic versions of the task.

The model suggests that reasoning in these tasks may be rational rather than subject to systematic bias. Oaksford and Chater (1994) said that

applying Bayesian model to the selection task involves specifying the alternative hypotheses that participants must choose between and define them in terms of their probability. So, for the selection task, you require 2 hypothesis –

Hypothesis 1 - 'if a card has p on one side then it has q on the other side'. The implied rule is 'if p then q'. That means p and q are dependent.

Hypothesis 2 – There is no relationship between p and q. That means they are independent. This is also called null hypothesis. In which case the implied rule 'if p then q' will be false. In this the probability of not-q when p can be more than zero and the probability of q could be less than the probability of p.

By using Bayes's theorem the researcher can revise the probabilities of hypotheses in the light of data which are more or less likely if the hypotheses are true. Oaksford and Chater proclaimed and found that if we believe right from the beginning that there is an equal possibility of proposed rule and null hypothesis being true and there are very low chances of p's and q's, then predicted preference order of card choices then is p > q > not-q > not-p order.

Several studies have been conducted thereafter to test this claim. Oberauer et al. (2004), compared the optimal data selection model with direct test. They observed that in the optimal data selection model, people believe even the most rare event as most informative and make predictions on the basis of that information. On the other hand, in case of direct test, participants were given lot of experience of stimuli having a combination of rate and common features and then given a four card task having rare and common features. The results did not show that four card tasks were related to the experienced frequencies. Thus, these results did not support the optimal data selection model and its supporting studies. Another criticism against optimal data selection model was that it was not specified how the selections were made.

8.3 GENERATING AND TESTING HYPOTHESES

Generally, in studies of conditional rule testing, people aregiven a rule and possible evidence which may or may not support or disconfirm the rule. Usually, in real-life situations we are not given rules to test but must generate possible rules (hypotheses) first which can then be tested. Basically, two main approaches have been used to test the process of generating and testing self-produced hypotheses. These are (a.) Wason's reversed 20 questions task, and (b.) performance in simulated research environments. Let us look at each one of them.

8.4 WASON'S REVERSED 20 QUESTIONS TASK

In 1960, Wason published a paper in which he outlined his experiment about testing the inductive reasoning. He devised a task called 2-4-6 task. Through this task he showed that people think illogically and irrationally.

In this experiment, participants were told that experimenter has a rule in his mind that applies to only set of threes. Participants were given these three numbers 2-4-6 and asked to discover the rule that experimenter had in his mind. To do this, they had to generate a different three number series that might or might not match with the rule. The participants were expected to announce their rule when they were very sure that they have got the right answer. The "2-4-6" rule the experimenter had in mind was "any ascending sequence". That means the correct rule was numbers in increasing order of magnitude. In most cases, participants not only formed hypotheses that were more restrictive, e.g., they formed hypotheses having an intervals of 2 between increasing numbers or they formed ' arithmetic series'. Not only thatbut participants kept on generating hypotheses that were consistent with their previously set hypothesis. Very few participants either tried out series that went against their own hypotheses or spontaneously varied their hypotheses. This further supported Wason's hypothesis of confirmation bias.Wason varied the experiment a bit and imposed a fine of 12.5 pence(money) for every incorrect rule announcement. This made participants cautious but did not change their confirmation bias(a tendency to seek out and attend only to information consistent with the hypothesis while ignoring falsifying information).

Tukey (1986) differed from Wason's conclusion that people do not behave rationally, rather he believed that participants do behave rationally in terms of various alternative philosophies of science. His study highlighted that participants were either not always testing particular hypotheses on each trial, but would quite often be examining instances 'at random' or they were 'different' in gathering information that could lead to useful hypotheses. In conclusion, he said that people appear to be irrational if Popperian philosophy of science is applied to the task, but if alternative approach to science testing is used then participants behaviour appears to be rational and intelligible.

8.5 SIMULATED RESEARCH ENVIRONMENTS

Though theoretically it is emphasized that more than one hypothesis should be considered at a time and falsification is important to verify the hypotheses, Wason et.al. showed through their experiments that most of the participants do not pay attention to alternative hypothesis and do not try to get potentially falsifying data. In other words, confirmation bias takes place.

Mynatt et.al. (1977,1978) conducted two experiments to verify this claim. In their 1977 study, they presented participants with a set of various shapes (such as triangles, circles and squares) displayed on computer in varying degrees of brightness (dim to bright) and moving particles whose motion was influenced by the objects. After observing the particle's movements in this universe, they were asked to produce a hypothesis that can explain the behaviour of the particle. They were allowed to make a hypothesis on the basis of the particle's behaviour with one particular configuration of objects. This configuration of objects was designed in

such a way that it favoured forming of wrong hypothesis in terms of object shape. After that they were asked to test the hypothesis in various environments. They were presented with two environments – one in which their observations could confirm the wrong hypothesis and second in which they could test alternative hypotheses. The idea was to see which environment they would choose. The results showed that they did not choose the second environment where they could test the alternative hypotheses. They showed confirmation bias by choosing the first environment where they could merely confirm their wrong hypothesis. But if they got explicit information that could falsify the initial hypothesis, they used it to reject the incorrect or wrong hypothesis. Instructions given to either emphasizing confirmation or disconfirmation had no effect on the participants' behaviour.

In their 1978 study, Mynatt et al. allowed participants to explore a very complex environment of 27 objects that differed in shape, size and brightness. The particles were deflected on approaching the objects. The angles of deflection were governed by a formula. In this experiment too, confirmation bias took place and participants did not make any attempt to falsify the hypotheses. Dunbar(1993) also got similar result in his study.

8.6 SUMMARY

In this unit we discussed how hypotheses are tested and how hypotheses are generated. Hypothesis testing refers to assessing hypotheses for truth/falsity against data. Hypothesis generation refers to deriving possible hypotheses from data for later testing. Wason's four card selection task was discussed in detail to describe hypothetico reasoning. Hypothetico reasoning refers to both deductive and inductive reasoning but Wason's emphasis was on checking out the falsification process while assessing the hypotheses. He used card selection tasks in various ways. Four of the main variants were abstract version, concrete version, drinking rule, and negative abstract version. His basic results showed that participants had confirmation bias and ignored the falsifying data.

Along with his team, Wason further checked the variables that might lead participants' difficulty in making correct decisions. They suspected that when information was presented on both sides of the cards and instructions included the phrase 'the other side of the card', participants may get confused and make mistakes. So, the information was presented on only the front side of the card masked to hide the appropriate part of the card. Yet they found no difference in the results in both conditions. They further investigated what happens when the instructions emphasize on falsification. That also did not change the performance of the participants. However, Wason and Shapiro (1971) found significant improvement in the performance when four card selection task was presented in concrete version. Bracewell (1974) found that results improved significantly when absolutely clear instructions were given, especially in concrete version. Evans(1984) held that in abstract version, matching bias takes place, i.e., participants simply pick the cards showing

the symbols mentioned in the rule. Johnson-Laird et al. (1972) found that memory cueing or availability of the information from past experience helps in making correct choices. Cheng and Holyoak's (1985) showed the role of permission schema and rationale given for the rule resulted in dramatic improvement in correct answers. Cosmides(1989) believed that human beings are evolutionary wired to have 'cheat detecting algorithm' and social contract pattern produce high rates of correct (falsifying) answers. Oaksford and Chater (1994) proposed comparing null and alternative hypotheses by using Bayes's theorem.

Even for hypotheses generation, Wason (1960) devised a special task in which people had to generate over restrictive hypothesis. The results showed that people had an overwhelming tendency to keep generating new hypotheses consistent with their initial hypothesis. Very few participants tried out developing hypotheses that were contradictory to their initial hypotheses or spontaneously varied their hypotheses. Even in simulated research environment, participants showed confirmation bias.

8.7 QUESTIONS :

1. Discuss in detail hypothesis testing with the help of four card selection tasks.

2. Elaborate on Cosmides' study on social contract theory and its implications for reasoning.

3. Discuss in detail Wason's work on generation of hypothesis.

4. Write a note on -

a) Basic results of Wason's four cards study
b) Pragmatic reasoning schemas
c) confirmation bias
d) Matching bias
e) Memory cueing

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