PROBLEM SOLVING AND DECISION MAKING

COGNITION

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THINKING

Sometimes people are seen talking to themselves. What are they actually doing? Others infer that they are **thinking**. If we question such a person, he might say that he was thinking 'about something', may be his wife, child, a friend, his job or anything he has experienced or would like to experience. All of us keep thinking most of the time, but normally, we do not talk out loud to ourselves while thinking. This means that something is going on in our '**minds**' most of the time, which can only be experienced and not necessarily be observed by others.

Thought is sometimes regarded as evolution's highest achievement and, indeed, as defining the essence of human existence. It is the fascinating capacity to reason, to solve problems, to create new ideas and concepts, which enable man to rise above the demands of mere survival; to ponder what might be, as well as, to understand what is.

Thinking is a complex multifaceted human phenomenon, and so the word "think" is used to express different meanings. For example, 'Can you think (remember) the name of that boy'? 'I think (believe or decide) I should not go to the party', 'To think of (expect or anticipate) taking a bribe is shameful', 'I cannot think (imagine) that he could be so naughty', 'He thinks (judges) very high of me'. All such uses if the word "think" captures most of our **cognitive functions**.

Thinking is closely linked to other mental activities especially **perception** and **memory**. Psychologists refer to these interrelated processes as **cognition**. The term cognition is derived from a *Latin* word, which in English means "to get to know". It is an active word implying that the brain is more than just a clay tablet or a mere three pounds of tissue matter which receives the marks of experience. The human mind is almost constantly in action, solving problems, organising our ideas and thoughts, and converting them into our normal spoken language. All these activities are aspects of cognition, of knowledge in action. Thus, the study of cognition focuses on processes people use to transform, reduce, elaborate, store, recover, and put to sensory input.

Like learning and memory, cognition too cannot be directly observed. So, we have to depend on indirect sources which help in inferring cognition. For example, if a person is able to solve a problem quickly, has good reasoning capacity with some creative and inventive aptitude, he is said to be intelligent. Much of the credit we give to a person for being intelligent is based on the effectiveness with which that person is able to apply cognitive processes in various situations. Once we have learned certain facts or skills for that matter, we are able to apply them to various new tasks.

Cognition is essentially a process of **knowing**. It encompasses thinking, decision making, judging, imagining, problem solving, categorising, and reasoning, i.e., all the higher mental processes of human beings. These diverse mental activities may seem to be a jumble of various odd topics without any common elements. But a common ground underlies them all, that is, they all depend on knowledge derived from learning and memory.

Thinking is the crown jewel of cognition. It is spectacularly brilliant, in some people; even sublime, among average folks; and, the fact that it happens at all, one of the great wonders of our species. Thinking about thinking, what some call meta-thinking, may seem an insurmountable task, since it seems to engage all of the themes mentioned previously – the detection of external energy, neurophysiology, perception, memory, language, imagery, and the developing person. Advances in cognitive psychology, particularly within the last twenty years, have led to a formidable arsenal of research techniques and theoretical models capable of disclosing some of the facts about the thought and casting them in a plausible framework of sound psychological theory.

The process of thinking consists of manipulation and interplay of **symbolic elements** such as images, words and concepts to represent aspects of reality. Sometimes, this interplay of symbolic elements may be directed and actively controlled by the person, as in a specific problem solving situation. This is called **Realistic thinking**. Here, the constraints of logic, evidence, and reality play a major role, and the whole course of thinking is guided by the requirements of the situation. Another type of thinking is the **Autistic thinking**. This is an extreme kind of wishful thinking wholly dominated by one's wants and feelings, with little or no regard for reality. It is more a case of fantasy and imagination or day dreaming.

Many of the problems we face in our daily life require mere reproduction of the solutions, which we have learned to arrive at in the past, under similar circumstances. This is called **Reproductive thinking**, which is largely understandable in terms of the processes of learning, memory and transfer. But, the matter of the thinking process is most clearly revealed when we get to solve a problem. The process of problem solving occurs whenever we encounter a barrier or a gap between our present situation and a desired goal, but find that the mere repetition of a preciously learned method does not enable us to reach that goal. Such a kind of thinking is known as **Productive thinking** or creativity, which requires the production of a new and original solution. An individual's own problem solving may be called creativity, whether or not that particular solution has been produced previously by someone else. What matters more is, whether the problem and its solution is novel for the individual. Problem solving represents a large portion of those activities usually referred to as 'thinking', and indeed, the two terms may be made synonyms by defining thinking as something which occurs when an individual writes, talks, recognises or solves a problem.

- **1. BASIC ELEMENTS OF THOUGHT**
- **UNITS OF THOUGHT**

Images, words and concepts are the three most significant building blocks of our thoughts.

(a) Images

Normally, we think of images as being visual or pictorial, but they can also be in the forms of taste, touch, smell and sound. When we think of a friend, we get auditory image of the voice or visual image of the gait[1]. Albeit, we use more than one of our senses in forming images, but images associated with different senses are not recalled with equal intensities (Lindsay & Norman, 1977). It has been found that visual, spatial and moving images are experienced most strongly, while images of sounds, taste, touch and smell, touch and smell are not experienced clearly or frequently. Roe (1951) found that physical scientists are more apt to think in visual images (pictures, diagrams), while social scientists think more in auditory (words, sounds). Similarly, images in black and white are frequently experienced, but coloured images are only sometimes reported: Thus, it is clear that an image is our recollection or reconstruction of sensory experience. However, it may not contain the recall of **actual** objects or sensations. We have heard people recalling dreams or hallucinations. Images could be concrete or abstract, vivid or dim, may fade with time or grow stronger. Vividness of images is largely governed by the variables of persons and

[1] Gait – Body movement as in the way of walking

situations. The most explicit and elaborate of all images is the **eidetic image** (photographic memory).

The process of thinking, whether directed or undirected, frequently involves a continuous flow, manipulations, or interplay of images and other symbolic elements. Organisations of elements are combined, constructed, destroyed and reassembled. Such organisations and reconstructions of elements permit us to discover new solutions to puzzling problems. There was controversy as to whether people could think without images (imageless thoughts). A positive role of imagery in thinking has been established with the argument that people do have images in thinking, but there may be lapses in proper reporting that creates the doubt expressed in the controversy mentioned above. Some people find a graph or a schematic diagram helpful while trying to understand a difficult concept or relation. But for a few others, the visual information provided by a graph has to be converted into verbal information to be meaningful to them. All the people having these two very different views are capable of understanding the data or the problem given, but they code the data differently. One group uses the code of visual elements, while the other uses the non-visual code. This difference in the usage of symbolic elements may have significant consequences in the thinking and problem solving behaviour of these people.

(b) Concepts

(c) Language

(d) <u>CONCEPT FORMATION</u>

If we ask a student in the class, what different objects does he/she notice in the room, his probable answer may be ‘chairs’, ‘books’, ‘blackboard’ etc. The nature of his response illustrates an important ingredient of human cognition. Although the world consists of a spectrum of objects and events, we tend to simplify and organise our surrounding by classifying together things which exhibit common features. The mental constructs which enable us to make such classifications are called **concepts** (Anglin, 1977). In other words, we simplify things by organising specific items into general cognitive categories and these mental groupings are called concepts. The mind reduces its work by **grouping similar events and objects** under the heading of a single concept. For example, an object having a trunk, branches and leaves is called a ‘tree’.

Concepts provide much information with a minimum of cognitive effort. And this is why we consider concepts as the basic building blocks of thought. Organising concepts into hierarchies further simplifies the process. The earliest naturalists sought to simplify and put into order the overwhelming complexity of some five million species of living organisms by clustering them into two basic categories namely the ‘Plant’ and ‘Animal’ kingdoms, and then further subdividing them into smaller categories in order to make the world easier to deal with by grouping similar kinds of information into manageable units.

Concept formation (or concept learning) refers to the discernment of the properties common to a class of objects or ideas. Concept formation is more limited in scope than thinking and seems readily susceptible to experimental analysis. The early definition of concept was “mental images, ideas, or processes”. For our purposes a concept may be defined in terms of certain critical features and the rules that relate those features. **Features**, as used here, are characteristics of an object or event that are also characteristic of other objects or events. A distinction between features can be made on the quantitative basis as well as on the qualitative basis. Mobility is a qualitative feature that can also be measured quantitatively. Your Ford Escort automobile may have mobility (a qualitative statement) but may not have as much mobility as someone else’s Honda City. Thus both dimensional (quantitative) features and attributional (qualitative) features enter into conceptual formation; both kinds are investigated.

<u>Learning Concepts</u>:

No human is born with a readymade stock of concepts. All of us acquire them gradually, and these reflect our knowledge about the world. Concepts are learned by direct teaching or by observation. In either of these processes, we learn things because our elders describe, narrate or portray them before us. A young child learns to recognise a dog and further differentiate it from a cat. The baby builds up an internal **schema** of the features which accompany the category ‘dog’ and gradually learn to apply the term dog correctly for the animals belonging to the same family and also to distinguish from a cat or cow or horse. These steps accomplished the baby abstracts (draws out) the relevant features of the concept ‘dog’ from the various instances and non-instances of that concept. The child now has learned the concept because of the **suggestions** and the **information** we provided.

Mostly we construct our own concepts by observing the instances (and non-instances) and not by having others to explain or narrate the concept to us. It is also possible that a baby who finds a cat intriguing learns to differentiate it from a dog all by himself, recognising all the salient features in size and structures (may be also differentiating the distinct sounds produced by the two). Thus, in thinking concepts can serve to **generalise**, to **differentiate**, or to **abstract**. Experience and awareness contribute significantly to the process of concept formation.

- **ASSOCIATION**

The oldest and most influential theory in learning is the principle of association – **associationism**. In its most succinct form, the principle holds that a bond will be formed between two events as those events are repeatedly presented together. Reinforcement, or a reward system, facilitates formation of the bond. The basic model of the principle postulates that the learning of a concept is a result of:

1. Reinforcing the correct pairing of a stimulus (for example, red boxes) with the response of identifying it as a concept;
2. Non-reinforcement (a form of punishment) the incorrect pairing of a stimulus (for example, red circles) with a response of identifying it as a concept.

(Such mechanistic viewpoints leave little room for the concept – prevalent among modern cognitive theorists – of internal structures that select, organise, and transform information.)

- **HYPOTHESIS TESTING**

The general notion, that people sometimes solve problems and form concepts by formulating and testing hypotheses has long been held in experimental psychology. The direct application of a hypothesis-testing model to concept learning by Bruner, Goodnow, and Austin (1956) in their book, A *Study of Thinking*, introduced a thorough methodological analysis of performance.

The initial stage in concept attainment is the selection of hypothesis or a strategy that is consistent with the objectives of our inquiry. The prime question is “What us to be gained by choosing one order as compared to another order of testing instances?” The first thing to be gained is, of course, an opportunity to obtain information appropriate to the objectives of one's inquiry. One may wish to choose an instance at any given point in concept attainment that can tell one the most about what the concept might be. To sum up, controlling the order of instances tested is to increase or decrease the cognitive strain involved in assimilating information. A well-contrived order of choice – a good "selection strategy" – makes it easier to keep track of what hypotheses have been found tenable or untenable on the basis of information encountered. A third advantage is not at first obvious. By following a certain order of selecting instances for testing one controls the degree of risk involved....

In a typical experiment, Bruner and his associates presented an entire concept universe (that is, all possible variations on a number of dimensions and attributes) to subjects and indicated one instance of an exemplar of the concept that the subjects were to attain. The subjects would pick one of the other instances, be told whether it was a positive or negative instance, then pick another instance, and so on until they attained the criterion (identified the concept).

The strategies subjects may select in concept formation include scanning and focusing each of which has its subtypes as follows:
Simultaneous Scanning – subjects start with all possible hypotheses and eliminate the untenable ones.

Successive Scanning – subjects begin with a single hypothesis, maintain it if successful, and, where it is unsuccessful, may change it to another that is based on all previous experience.

Conservative Focusing – subjects formulate a hypothesis, select a positive instance of it as a focus, and then make a sequence of reformulations (each of which changes only one feature), noting each time which turns out to be positive and which negative.

Focus Gambling is characterised by changing more than one feature at a time. Although the conservative-focusing technique is methodological and likely to lead to a valid concept, subjects may opt for a gamble in the expectation that they may determine the concept more quickly.
Of the strategies defined above, conservative focusing tends to be the most effective (Bourne, 1963); scanning techniques give only a marginal success. A

difficulty with the Bruner model is that it assumes that subjects hold to a single strategy, when, in actuality, some vacillate, shifting from strategy to strategy throughout the task.

- **2. REASONING**
- **<u>LOGIC:</u>**

Thought or *thinking* refers to the general process of considering an issue in the mind, while **logic** is the science of thinking. Although two people may think about the same thing, their conclusions – both reached through thought – may differ, one being *logical*, the other *illogical*.

Thinking and logic has been the subject of speculation for a long time. More than two thousand years ago, Aristotle introduced a system of reasoning or of validating arguments that is called the **syllogism**. A syllogism has three steps – a major premise, a minor premise, and a conclusion, in that order.

Major Premise	All **men** [Middle term (M)] are **mortal** [Predicate (P)]**.**
Minor Premise	**Socrates** [Subject(S)] is a **man**.
Conclusion	Therefore, **Socrates** [Subject(S)] is **mortal**.

A conclusion reached by means of syllogistic reasoning is considered valid, or true, if the premises are accurate and the form is correct. It is therefore possible to use syllogistic logic for the validation of arguments. Illogical conclusions can be determined and their cause isolated. This is a succinct statement of the theoretical basis of much current research on thinking and logic.

- **<u>INDUCTION AND DEDUCTION</u>**

Induction – induction, in logic, the process of reasoning from the particular to the general. Francis Bacon proposed induction as the logic of scientific discovery and deduction as the logic of argumentation.

Deduction – in logic:

1. Traditionally, it is the process of drawing, by reasoning, particular conclusions from more general principles assumed to be true. The Aristotelian Syllogism is the classic example of deductive logic in the tradition.
2. In contemporary logic, any statement derived by a transformed rule upon an axiom; more generally, the term now refers to a process of deriving theorems from axioms, or conclusions from premises, by formal rules (transformational rules).

- **INFERENCES AND DEDUCTIVE REASONING**

If Bill is taller than Jeff and Jeff is shorter than Ryan, then is Bill taller than Ryan? Take a moment and figure this out. Some people work out this problem (which, of course, has no definitive conclusion) by drawing little figures in which the relative height of the Bill, Jeff and Ryan are depicted.

Your conclusion was reached through a process of reasoning called **deductive reasoning** which is the logical technique in which particular conclusions are drawn from more general principles. Johnson-Laird (1995) has identified four main issues in the cognitive study of deductive logic.

1. Relational inferences based on the logical properties of such relations as *greater than, on the right of, and after*. (In the case of Bill et al. you had to use a “greater than” logic.)

2. Propositional inferences based on negation and on such connectives as *if, or,* and *and*. (for example, you might rephrase the above problem as “If Bill is taller....”.)

3. Syllogisms based on pairs of premises that each contains a single qualifier, such as *all* or *some*. (in the next section we will study syllogisms that have such qualifiers, such as, “All psychologists are brilliant; some psychologists wear glasses....”.)

4. Multiplying of quantified inferences based on premises containing more than one qualifier, such as *Some French poodles are more expensive than any other type of dog*.

These four models, or contingencies involved in decision making, have been formalised by logicians into a type of predicate calcus (*viz*. that branch of symbolic logic that deals with relations between propositions and their internal structure – symbols are used to represent the subject and predicate of a proposition).

- **SYLLOGISTIC REASONING**

(refer to book, Solso)

- **SOME SOURCES OF ERROR**

If human reasoning was based on logic, then it would be an entirely domain independent process. However, that is not to say that we would expect no influence of problem content or context. Logicist authors have argued that there is an interpretative process in which the particular problem content must be translated into an underlying abstract form before logical processes can be applied. If participants in the experiment represent the premises of an argument in a different manner to that expected by the experimenter, then they may be classified as making errors even though the process of reasoning was logical. For example, someone given the statement "Some students live in hostel accommodation" might draw the conclusion that "Some students do not live in hostel accommodation". This could be classified as a logical fallacy because "some" does not exclude "all." It is perfectly reasonable for people to represent "some" as meaning "some but not all," as indeed they do.

- **The role of Mood States**

Research on how moods alter both judgement and processing informs research on how moods alter information seeking. For instance, research on mood and judgements sheds light on how mood might alter the acquisition of competency-assessment information. When individuals judge whether they have the competency to do a task, sad moods confer more negative information about one's competency than do happy moods.

- **The role of Beliefs**

Over the years, however, the role of knowledge and belief in deductive reasoning tasks has proved so influential hat many researchers have abandoned logic as both a descriptive and a normative theory of human reasoning. For example, it has been suggested that:

- ✓ People may reason using heuristics that help to maximise information gain
- ✓ People treat reasoning problems as decision-making tasks in which personal goals and utilities come into play
- ✓ Reasoning is governed by principles of pragmatic relevance
- ✓ People reason using domain-specific processes resulting from innate reasoning modules.

The influence of prior knowledge considers some the arguments on:

- Influence of pragmatic factors in conditional reasoning
- Belief-bias effect in syllogistic reasoning

- **The Confirmation Bias: Searching for Positive Evidence**

One of the most pervasive topics in the cognitive psychology of science has been the tendency to selectively look for and latch onto evidence that confirms our theory and to deny, distort, or dismiss evidence that contradicts it. One the first to put confirmation bias on the front burner of the cognitive psychology was **Peter Wason**.

- **3. PROBLEM SOLVING**

The process of thinking consists of the manipulation and interplay of symbolic elements, such as, images, words and concepts to represent various aspects of reality. In such realistic thinking, the constraints of logic, evidence, and reality play as a major role and the whole course of thinking is guided by the requirements of the objective situation. This type of directed thinking is obviously useful and adaptive. Viewed in this adaptive context, we should expect the nature of the thinking process to be most clearly revealed when we set about to solve a problem. **Problem solving** occurs whenever we encounter a barrier or a gap between the present situation and a desired goal, but find that the mere repetition of a previously learned method does not enable us to reach the goal. Many of the problems we face in our daily life conveniently require nothing more than reproducing what we have learned to do in the past in similar situations. Such reproductive thinking can be explained in terms of the processes of learning, memory and transfer.

Problem solving differs from reasoning. Whereas reasoning requires us to follow one particular logical chain to answer a question problem solving depends, to a great extent, on the nature of the problem. But productive thinking requires the production of original and new solutions. Here, the problem solving involves those skills that can cope with novel situations for which there is no well learned response. All of us are continuously involved in problem solving. Some problems are simple and unstructured, but others may be complex and difficult. In cases of ill-defined problems such as writing a good story or designing a beautiful house, there are no agreed-on steps or rules that will produce a product generally accepted as a solution. By contrast well defined problems such as of mathematics or logic, have a clear structure; there is always a clear standard for deciding whether the problem has been solved or not. In laboratories, psychologists generally study how people solve well defined problems because such problems have built-in criteria by which the solution can be evaluated. Psychologists also try to understand how people solve problems and what are the elementary reasoning strategies used in solving problems.

- **PREPARATION**

For the purpose of analysis, psychologists sometimes divide the solutions of well defined, low knowledge problems into four partly overlapping stages:

1. **Understanding the problem**

   No single aspect of problem solving has a greater impact on the speed and likelihood of a correct solution than how the problem is initially interpreted. The same problem can often be represented in several different ways, and some representations bring a solution to the minds more readily than others. The game of numbers, scrabbles, tic-tac-toe (Xs and Os), where we try to connect all elements in a row, column or the diagonal arm may be the examples.

2. & 3. **Solution plan and Strategies**

Several different strategies can be used for solving problems. A person's conception of the possible moves is known as the **problem space**. Problem spaces can characterise people's behaviour in solving such problems as proving theorems in logic, making mathematical derivations, and playing games like chess or checkers. Each time a move is made, the person is seen as moving from one "problem state" to another.

- Kinds of Problems
- Representing and Organising the Problem

- **PRODUCTION: GENERATING SOLUTIONS**

1. Trial & Error – when the possible solutions to a problem are few, we may solve it through trial and error. Whenever we are out in a new situation, we try to understand it only through trial and error. For example, a new TV set, we tend to play around with the buttons. Trial and error is the most basic problem solving strategy. It usually involves a more or less random series of different actions when there is no way of knowing what substances would work as a light bulb filament.

2. Hypothesis testing – closely related to the above method is hypothesis testing. Example, very close to our experience is power failure, suppose we enter our home and find no current, we shall check the main switch and if no fault is found we might check with the neighbours if they have, we shall check our main switch again to rectify the probable fault with the fuse wire. What we do here is that we try many possible alternatives. We entertain a series of hypotheses about the problem in a systematic and structured way. We eliminate each hypothesis using this testing method of possible hypotheses, stored in the memory, each of which could account for the situation. We should also be able to take appropriate action to test and eliminate the hypothesis.

3. Algorithms – some problems can be solved by a strategy called algorithm, a precisely stated **set of rules** which usually works for solving problems of a

particular type. This strategy too, was proposed by the problem solving experts, Newell & Simon (1972). This is a logical, methodological, stepwise procedure. Actually it originated in the field of mathematics, such as routines for subtraction, for long division, for solving sets of linear equations and so on. This concept has since been applied to other types of problems also.

The difficulty with the ‘generate-and-test’ algorithm is that for any reasonably interesting problem, the number of moves that must be considered is astronomically large. In chess, for example, it is estimated that the problem space of all possible sequences of moves has close to 10120 branches; obviously no one could begin to examine more than the barest fraction of such an enormous problem space possibilities. Therefore, the use of algorithms is not always practical. Suppose we are given a task to arrange the letters **koknc** to form an English word. An algorithmic solution would be to arrange the letters systematically in all possible ways until a menaningful combination appears, obviously it would be a time consuming procedure, because there can be 120 possible combinations of these five letters. Most people therefore, would follow a short cut strategy. They would focus on the letter combinations likely to appear in English, such as **Kn** at the beginning of a word or **ck** at the end. Using this approach, they would probably discover the word __________ quite quickly (Dominoski & Loftus, 1979).

4. Heuristics – algorithms are not suitable for most of our problems primarily because we do not have the time required in such techniques. A rule of the thumb, short cut problem solving strategy, as already mentioned for ‘knock’; can be called heuristic method – search method that relies on plausible guesses about likely solution paths. Normally, we use it in complex situations. Though it does not guarantee solution in all cases, it is certainly very useful in reaching a solution. The heuristics used for solving anagrams (scrambled word problem) or coded messages are very specific to such problems. All of us have a repertoire of these strategies based on bits of knowledge we have picked up, **rules we have learned**, or hypotheses which have worked for us in the past. We come across people saying “I am reminded of a similar problem” or “it might be done the way I did for so and so”, while solving a problem.

Another heuristic, often very useful, is to break a larger problem into **sub goals**. Sub goal analysis, of course, is not the only problem solving strategy people adopt. Another general heuristic, often applied to problems with a very specific goal, is often **means-end analysis**. It involves comparing one's current position with a desired end position and then trying to find a means of closing the gap between the two. For example, suppose the vehicle on which a student goes to the college develops some trouble and he has very little time left to reach the college. The means-end analysis method will tell him what would be the right decision to cover the distance left, considering the time in hand – walking, running or hiring some other vehicle. He "searches through the problem space" some solution by considering other means of transportation.

A special form of means-end analysis consists of devising a plan by **working backward** from the goal state. Suppose someone wants to buy a house. He does not have enough money, but the need is so pressing that unless he acquires one he would be on the streets. He plans to do a part-time job (a first step towards the fulfilment of the goal) for six months to add the remuneration from it to his present salary and meet the cost of the house. It is a common reasoning strategy to work backwards for reducing the difference between the goal and the current position. By reasoning backward from a distant goal, the solver can reach the first step to be taken immediately.

Another good strategy may be in the form of **problem reduction**. We break a large problem into a number of smaller problems, easier to handle or within our power to solve. Architects use this strategy in designing building. The standard way to proceed is by progressive deepening; planning at a general level (no. of rooms) before planning at a level of greater details (no. and locations of tiles or marbles).

Sometimes a good strategy for attacking a large problem is to begin by solving a similar but smaller problem within called **simplification**, in order to generalise the method of solution for the larger original problem. Anderson (1980) has suggested a good example of problems simplification. If one has to plan a party for one hundred people, he should first plan on a small group successfully and then enlarge it on a desired number.

5. Analogy – another very significant and powerful strategy frequently used in problem solving is one in which the solver draws an analogy between the current problem and a problem from a different but familiar domain having a similar logical structure (Glass, Holyoak & Santa, 1979). In an analogy, a parallel is drawn between the two systems whose parts are interrelated in a similar way. For example, the flow of electric current through a circuit is somewhat analogous to the flow of water through pipes in a house. The motion of electrons around the nucleus of an atom is somewhat analogous to the motion of planets revolving round the sun. Textbooks often give an incomprehensive abstract description of the concept of a new concept and then follow it with several worked out problems as examples.

6. Insight – all problems are not necessarily solved by systematic step by step ways like those described above. Often a crucial insight is needed to solve a problem. It is a vision of how all parts fit together, or how to represent the problem differently. In other words, insights are **sudden (flashes of inspiration)** that allows us to solve a problem, often in novel ways. 'Eureka' or 'Aha' is indicative of the feeling of insight when all the different elements of a problem suddenly come together. This experience can come at the end of a directed process of hypothesis testing, or seemingly, all at once. The insight is usually visual and seems to consist of a simultaneous vision of the total problem.

- **JUDGMENT**

The last component of problem solving is evaluating the quality of the proposed solution. While solving a well-defined problem, we often come to know immediately whether our answer is correct or not. For these problems, verifying the solution is a trivial and obvious procedure. But with the ill-defined problems having no strict criteria for a good solution, evaluation of a proposed solution may be a major task. Not all problem solving efforts result in achieving successful solutions. If the problem has not been fully grasped and no clue has been found to eliminate various alternatives, the solution attempts become chaotic. A satisfactory solution is one in which the problem solver successfully combines experience and imagination to come up with a workable idea. After our assessment of the situation, we begin to form a number of hypotheses about the possible causes of the problem and then attempt to evaluate the evidences supporting or contradicting these hypotheses.

At the end, it is essential to mention that the steps for problem solving do not always require equal attention. Sometimes, they may run together. Often people trying to find a solution begin suggesting options almost immediately. It has been observed quite often that id someone talks about his trouble (may be a stomach disorder or any other health problem) most of us will come up with some or other suggestion for treatment confidently. Occasionally, the number of attractive options is small and the final step is simple. Often, however, people encounter snags in reaching an effective solution.

- **IMPEDIMENTS TO SOLUTION or FACTORS AFFECTING PROBLEM SOLVING**

Problem solving is susceptible to many influences other than simply the problem itself.

1. **Emotional and motivational factors**
   We have already understood individual differences in our entire functioning. Here, we are not interested in giving an account of those factors which are in the shape of traits, but are transitory or state factors. For example, anxiety, aggression or frustration resulting from the problem solving process itself or from other sources in our life at that time. If these emotions are present to any noticeable extent, they are sure to hamper our solution process, severe anxiety is sometimes helpful in increasing the performance, but it must not cross the desirable limit. Frustration and conflict of any kind also negatively influence our performance,

2. **Attention span**
   It also limits our ability to solve problems. Lindsay & Norman (1977) point out, if we try to plan out our whole strategy ahead of time, we cannot even play the simple game of tic-tact-toe. We shall find it impossible to keep in mind all the combinations of possible moves and countermoves involved in the game. The problem solving strategies we have discussed are in part designed to keep the problem down to workable size. But, in addition, we rely on external aids, as well as memory aids. Memory aids provide ways of structuring a large amount

of knowledge, so that they can be easily stored in the long-term memory and retrieved when needed.

3. **Past experience**

Past experiences have a powerful influence on problem solving. If the present problem is identical or even similar to an earlier problem and the objects used to achieve the goal in the earlier one are at hand, the past experience is cued from memory and the old solution is simply repeated. This use of old knowledge in new situations amounts to '**positive transfer**' of learning. The example of power failure cited earlier can be recalled here. Whatever we attempt to do is very much the outcome of previous learning of the consequences of problem solving.

The transfer of relevant past experiences generally speeds up the solution of a current problem. But the transfer is not always positive. Sometimes, our past training leads us to such approaches to new problems that are actually **detrimental**. We may have false presuppositions or hidden assumptions about the situation. When we automatically apply an inappropriate strategy to a problem and cling rigidly to it, we are hampered by **fixation**. Fixations can inhibit or prevent successful solutions.

4. **Confirmation bias**

One of the major obstacles to problem solving is our natural tendency to search for information which confirms our hypothesis, a phenomenon known as the **confirmation bias**.

5. **Social factors**

Sometimes it has been observed that if a problem is being solved in a social situation, the situation itself militates against successful solution. Either the solution would be in shape of conformity or complete withdrawal. The fear of looking by taking a risk, usually goes with not wanting to be different. Many people hold back inventive ideas because they are afraid that others may consider it outlandish or inappropriate.

There may be other factors also affecting problem solving, such as complexity of the outcome, the degree to which the solution is conceptualised and the kind of resources which are available.

- **<u>CREATIVITY AND PROBLEM SOLVING</u>**

Creativity has been defined as the **ability to produce ideas which are both novel and valuable**.

The creative process involves the following:

1. Preparation
2. Incubation
3. Illumination
4. Verification

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