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in auditory (sound) form. In other words, people tend to talk inside their own heads. Although some images are certainly stored in STM in a kind of visual sketch pad (A.D. Baddeley, 1986), auditory storage accounts for much of short-term encoding.

Short-term memory is a working memory which process the information in a working and active system. It was proposed that STM consists of three interrelated systems, viz., a central executive that controls and coordinates the other two systems, a visual sketch pad of sorts and a kind of auditory recorder (Baddeley, 1986, Baddeley and Hitch, 1974; Engle and Kane, 2004). The central executive would act as interpreter for both the visual and auditory information in STM. For example, when a person is reading a book, the sketch pad will contains images of the people and events of the particular passage being read while the recorder plays the dialogue in the person's head. The central executive interprets the information from both systems and pulls it all together.

Short-term memory can be taken as a kind of desk where the files are kept. As files are on the desk one can see them, read them and work with them. The files are now conscious material and will stay that way as long as they are on the desk.

Capacity

George Miller (1956) was interested to know the capacity of STM or how much information human can hold in short-term memory at one time. He used a memory list called the digit. It was a span test in which a series of numbers were read to subjects in the experiments who were then asked to recall the numbers in order. Each series gets longer and longer, until the subjects cannot recall any of the numbers in order. Miller concluded that the capacity of STM is about seven items or pieces of information, plus or minutes two items, Miller called it the magical number seven plus or minus two.

Chunking

If the bit of information is combined into meaningful units or chunks, more information can be held in STM; for example, recording the last sequence of number as 654-789-3217, instead of 10 bits of information. Then, there would be only three chunks that read like a phone number and would be easier to memorize. The process of recording or reorganizing the information is called chunking.

Rehearsal

Is often verbal, giving the impression of an inner eye. One way to use your visualization skills is to maintain the image of an object or a scene for a while after review.

Rehearsal work best when we need to briefly remember a list of items, but rehearsal does not work well in the long-term due to rotary repeating information without imparting meaning to it. Remembering information for a longer time works better when we add meaning to it.

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Long-term memory

Long-term memory is a relatively permanent memory that stores huge amounts of information for a long time. John Von Neurman, a distinguished Computer scientist, put the size at 2.8*10 powers of 20 (280 quintillion) bits. In other words, our storage capacity is virtually unlimited. He assumed that we never forget anything, but even considering that we do forget things, we can hold several billion times more information than a large computer.

At the top level, it is divided into substructures of explicit memory and implicit memory. In simple terms, explicit memory has to do with remembering who, what, where, when and why; implicit memory has to do with remembering how. Explicit memory can be further subdivided into episodic and semantic memory and distinguished as either retrospective or prospective memory. Implicit memory includes the systems involved in procedural memory, priming, and classical conditioning.

Explicit memory

Explicit memory is the conscious recollection of information, such as specific facts or events and, at least in humans, information that can be verbally communicated (Tulving, 1989, 2000). Examples of using explicit memory include recounting the events of a movie we have seen and describing the basic principle of psychology to someone. However, we do not need to discuss explicit memory. Simply sitting and consciously reflecting about Einstein's theory of relatively or recollecting the dates of the last weekend involves explicit memory.

Canadian cognitive psychologist, Tulving (1972, 1989, and 2000) has been the foremost advocate of distinguishing between two subtypes of explicit memory—episodic and semantic. Episodic memory is the retention of information about the where and when of life's happenings. It is autobiographical; for example, episodic memory includes the detail of what it was like when our younger brother or sister was born, what happened on our first date.

Semantic memory is a person's knowledge about the world. An important aspect of semantic memory is that it appears to be independent of an individual's personal memory of the past. Another aspect of explicit memory, which is currently a hot topic, is the difference between retrospective memory (remembering the past), and prospective memory (remembering information about doing something in the future) (Burgess, Quayle, and Frith, 2001; Graf, 2004; Kliegel and others, 2001; McDaniel and Einstein, 2000). Prospective memory includes memory for intentions. Some failures in prospective memory are referred to as 'absentmindedness'. We become more absentminded when we become preoccupied with something else, or are distracted by something, or are under a lot of time pressure (Matlin, 2004).

Implicit memory

Another type of LTM is related to unconsciously remembering skills and perceptions rather than consciously remembering facts.

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Implicit memory is memory in which behaviour is affected by prior experience, without that experience being consciously recollected. Examples of implicit memory include the skills of playing tennis and typing, as well as the repetition in our mind of a song we heard in the supermarket, even though we did not consciously attend to the music. The subsystems of implicit memory consist of memories that we are not aware of, yet predispose us to behave in certain ways (Schacter, 2000).

- **Procedural memory:** Procedural memory involves memory for skills. For example, once we have learnt to drive a car, we remember how to do it; we do not have to consciously remember how to drive the car as we put the key in the ignition, turn the steering wheel, push on the gas pedal, hit the brakes, and so on.
- **Priming:** Priming is the activation of information that people already have in storage to help them remember new information better and faster (Badgaiyan, Schacter, and Alpert, 2001; Huber and others, 2001). However, priming can lead to false memories.
- **Classical conditioning:** Classical conditioning is a form of learning. Classical conditioning involves the automatic learning of associations between stimuli. For instance, a person who is constantly criticized may develop high blood pressure or other physical problems. Classically conditioned associations involve implicit, unconscious memory.

3.10.2 Types of Remembering and Memory as a Constructive Process

There are different types of remembering, which depends on how well we know the information. They are described as follows:

- **Recall method:** It is *the highest level of learning.* When we recall the information immediately, it is a test of retention. In experiment on remembering and forgetting one is first made to learn something. After sometimes has passed, he is asked to recall what he had learned.
- **Recognition method:** It is another test of retention. When the same word is presented with some other words, we recognize it very easily.
- **Relearning:** When we have no recollection, but can relearn the information faster than the first time it was learned. In case of perfect recall, or there is no recall, the subject is again made to learn the material in the same method.
- **Reconstruction method:** Here, the subject is tested for the reproduction of the order of arrangement of stimuli. In this method, stimuli are presented to the subject in a certain order—temporal and spatial. After the stimuli are presented their arrangement is disturbed and has to set them in the presented order.

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Memory as a constructive process

The meaning of forgetting in terms of failure to retrieve gives the idea that memory storage is static. Memory and remembering has been shown to be constructive process. The reconstructive nature of memory is evident when we recall some event. If we compare recollections of the story of a movie we will notice that different people have constructed the same story in different manner. In fact, rumours often show our tendency to highlight certain details and assimilating some. It seems that recall is always a combination of retrieval and reconstruction. Three main tendencies are sharpening, levelling, and assimilation.

CHECK YOUR PROGRESS

10. What is transfer of learning?
11. What is comorbidity?
12. What are the three interrelated systems of STM?
13. What are the types of remembering?

3.11 THE PROCESS OF MEMORY MAKING

3.11.1 Eye Witness and False Memory

Human memory as an active process creates a major challenge when we collect eye witness account of accidents and other events. People often interpret what they see in terms of what they expect and their memories reflect that. It has been found that we always actively process our memories and try to fit them in the schema and beliefs that we hold about the situation. It is only when we look at the overall meaning and context of a memory that we can really judge about the accuracy of accounts. The details do not constitute the most significant aspects of memory in such cases. Eye witness memory in which people are called on to report what they saw in relation to the crime may also contain errors (Schacter, 2001). Hundreds of individuals have been harmed by witnesses who made a mistake that could have been avoided (Loftus, 2003, Radelet, 2002). The amount of time that has passed between an incident and a person's recollection of it is a critical factor in eye witness testimony.

3.11.2 Retrieving Memory

To retrieve something from our mental 'data banks', we search our store of memory to find the relevant information. Memory retrieval takes place when information is taken out of storage. Our memories are affected by a number of things, including the pattern of facts we remember, the situations we associate with memories, and the personal or emotional context. It is like finding a book we wanted only with a few pages remaining. We have to reconstruct the rest. There has been a flurry of

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interest in these memory quirks and glitches. Figure 3.4 represents the process of memory retrieval.

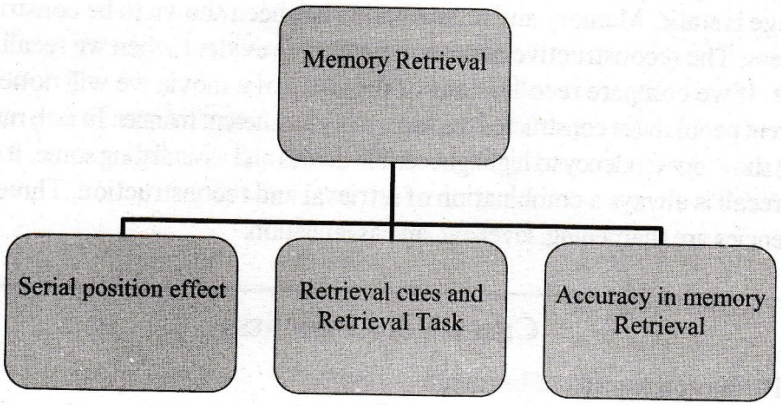

Fig. 3.4 Memory Retrieval Process

The process of retrieving memory is as follows:

- **Serial position effect**

Serial position effect is the tendency for items at the beginning and at the end of a list to be recalled more readily than items in the middle of the list (Howard and Kahana, 1999; Surprenant, 2001). This phenomenon is known as primary and recency effect. The primary effect refers to better recall for items at the beginning of a list. The recency effect refers to better recall for items at the end of the list. It is because of the primary effect that the first few items in the list are easily remembered as they are rehearsed more or receive more elaborative processing than do words later in the list (Atkinson and Shiffrin, 1968; Craik and Tulving, 1975).

Working memory is relatively empty when they enter, so there is little competition for rehearsal time, and because they get more rehearsal, they stay in working memory longer and are more likely to be successfully encoded into LTM. In contrast, many items from the middle of the list drop out of working memory before being encoded into LTM.

- **Retrieval cues and the retrieval task**

Two other factors involved in retrieval are: (i) the nature of the cues that can prompt your memory, and (ii) the retrieval task that you set for yourself. If effective cues, for what we are trying to remember, do not seem to be available, we need to create them; a process that takes place in working memory. For example, if we have a block about remembering a new friend's name, we might go through the alphabet generating names that begin with each letter. If we manage to stumble across the right name, we will probably recognize it.

Thus, we can learn to generate retrieval cues (Allan and others, 2001). One good strategy is to use different subcategories as retrieval cues. Although cues

help, but our success in retrieving information also depends on the task we have set for ourselves. Following are some task and cue that affect the ability to retrieve memory:

- **Recall and recognition:** Recall is a memory task in which the individual has to retrieve previously learned information. Recognition is memory task in which the individual only has to identify learned items when they are presented.
- **Encoding specificity:** Amount of information present at the time of encoding or learning. It can be served as retrieval cue (Hanna and Remington, 2001).
- **Context and state:** Change between encoding and retrieval cause memory to fail. Internal state can influence memory.
- **Priming:** Priming is a form of implicit memory that is non conscious. People remember information better and faster when it is preceded by similar information (a Cue).
- **Tip-of-the-tongue phenomenon:** The TOT state occurs when people are confident that they know something but can't quite pull it out of memory (Schwartz, 2002).

• **Accuracy in memory retrieval**

The following are the factors that lead to accuracy in memory retrieval:

- **Flashbulb memories:** They are memories of emotionally significant events that people often recall with more accuracy and vivid imagery than every day events (Davidson and Glisky, 2002).
- **Personal trauma:** Emotional arousing experience that may create more detailed, long-lasting memories than other (Langer, 1991).
- **Eye-witness testimony:** As explained earlier in the unit, eye-witnesses account for any event that occurred. However, they remember what they saw or imagine what they saw. Also, this memory will be remembered for a long time.
- **Repressed memories:** Psychodynamic theory depicted that the main function of the repression is to protect the individual from threatening information. Repression does not erase a memory, but it makes conscious remembering extremely difficult (Anderson and Green, 2001).

3.11.3 Repressed Memory

Repressed memory is a hypothetical concept used to describe a significant memory, usually of a traumatic nature, that has become unavailable for recall; also called motivated forgetting in which a subject blocks out painful or traumatic times in one's life. This is not the same as amnesia, which is a term for any instance in which memories are either not stored in the first place (such as with traumatic head injuries when short-term memory does not transfer to long-term memory) or forgotten.

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The term is used to describe memories that have been dissociated from awareness as well as those that have been repressed without dissociation. Repressed memory syndrome, the clinical term used to describe repressed memories, is often compared to psychogenic amnesia, and some sources compare the two as equivalent.

> In Freud's theory of 'repression' the mind automatically banishes traumatic events from memory to prevent overwhelming anxiety. Freud further theorized that repressed memories cause 'neurosis', which could be cured if the memories were made conscious. While all this is taught in introductory psychology courses and has been taken by novelists and screenwriters to be a truism, Freud's repression theory has never been verified by rigorous scientific proof.
>
> John Hockmann

A repressed memory is the memory of a traumatic event unconsciously retained in the mind, where it is said to adversely affect conscious thought, desire, and action.

It is common to consciously repress unpleasant experiences. Many psychologists believe that *un*conscious repression of traumatic experiences, such as sexual abuse or rape is a defence mechanism which backfires. The unpleasant experience is forgotten, but not forgiven. It lurks beneath consciousness and allegedly causes a myriad of psychological and physical problems from bulimia to insomnia to suicide.

The theory of *unconsciously* repressing the memory of traumatic experiences is controversial. There is little scientific evidence to support either the notion that traumatic experiences are typically unconsciously repressed or that unconscious memories of traumatic events are significant causal factors in physical or mental illness. Most people do not forget traumatic experiences unless they are rendered unconscious at the time of the experience. No one has identified a single case where a specific traumatic experience in childhood was repressed and the repressed memory of the event, rather than the event itself, caused a specific psychiatric or physical disorder in adulthood.

The strength of the scientific evidence for repression depends on exactly how the term is defined. When defined narrowly as intentional suppression of an experience, there is little reason to doubt that it exists. However, when we talk about a repression mechanism that operates unconsciously and defensively to block out traumatic experiences, the picture becomes considerably murkier.

Psychologist Lenore Terr, a defender of repressed memory therapy, argues that repression occurs for repeated or multiple traumas, such as a repeatedly abused child. Schacter notes that 'hundreds of studies have shown that repetition of information leads to improved memory, not loss of memory, for that information'.

He also notes that people who have experienced repeated traumas in war, even children, generally remember their experiences. A person who suffers a great trauma often finds that he/she cannot get the event out of her mind or dreams. Terr's theory is that the child becomes practiced at repression to banish the awful events from awareness, and forgetting might aid in the child's survival. Her dissociative theory, however, is based on speculation rather than scientific evidence.

Most psychologists accept as fact that it is quite common to *consciously* repress unpleasant experiences, even sexual abuse, and to spontaneously remember such events long afterward. Most of the controversy centres around recovered memories during repressed memory therapy (RMT). Critics of RMT maintain that many therapists are not helping patients recover repressed memories, but are suggesting and planting false memories of alien abduction, sexual abuse, and satanic rituals.

3.11.4 Improving Memory

Steps for memory improvement are as follows:

(i) We must be in a relaxed mood

(ii) We must write down the things that we are supposed to remember in a piece of paper.

(iii) We must read it aloud (if possible) once or twice and recite it two to three times.

By following the steps mentioned, we will surely retain the item longer and find it easier to recall it when in need.

Most of us might have complained about our memory one time or other. However, some of us have been frequently complaining about our poor memory. When we generally talk about poor memory we are really talking about poor recollection. Recollection is possible only if the content is retained in memory. This is possible only if we have recorded it into memory. That is, unless we have not assimilated, we cannot recall at all. That is why William James, usually thought of as the fathers of *psychology*, and many others including mnemonists give emphasis to how we record things into our memory.

Even if we record something correctly in our memory, we may not be able to recall it. This is due to many reasons, the main reasons being problems in retention and stress. The former can be solved by systematic revision and the latter by practicing some Stress Management Techniques.

Now, let us discuss five simple techniques to improve memory: Four of these techniques are used to improve assimilation and thus to have longer retention. The last one is a simple strategy for recollection.

(i) Chunking

Perhaps Chunking is the oldest method used in memorization. It has already been mentioned earlier in the unit. In this method, the items to be memorized are divided

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into small and easily memorizable chunks or groups. This method works best when the order of the items is not important.

This method is found to be particularly well suited for memorizing multi-digit numbers (eg., ID numbers., telephone numbers., etc.) and for committing complicated spellings to memory.

If possible, we can organize the material as meaningfully as we can and think out relationships among each group. This not only improves learning ability and retention, but also aids in faster and effortless recollection.

(ii) Rhyming

This is also one of the popular and oldest methods in memorization. This technique makes use of the fact that we have a natural tendency to remember rhymes and rhythms. If possible, we can create rhymes and it will not only aid in improving our memory, but in improving our creativity as well.

(iii) Mediation/bridging

In this method, a bridge is built in between the items given to be memorized. This technique is best suited for learning material involving word pairs or material that can be reduced to word pairs. An example often cited by memory experts is the learning of the capital of Poland. The capital of Poland is Warsaw. World War II started with Germany's attack on Poland. Thus it may be arranged as Poland SAW War first.

Here, the word pair to be connected together is Poland and Warsaw. The additional information of the World War II is used as a bridge or mediator in bringing these two words together. Again, like other techniques, the mediation technique calls for the learner's active participation in the learning process. This is because one is to bring in the mediator or the bridge from relevant items one has learned.

(iv) Bed-time recital

In this technique, we do our recital or rote learning just before going to bed. The mind in the process of sleeping would then arrange the information in a systematic and effective way when we are sleeping. Psychologists have also found that if we sleep after thinking about your problems there is a better chance that you arrive at a solution the next day.

(v) Trying by not trying

All of us apply this method knowingly or unknowingly. Sometimes when we try to recall we may not be able to recall it at that time even if we are sure that we know it very well. We experience a blocking that prevents us from recalling it. Normally, we tend to try again and again, but in vain. To handle this situation we just have to keep away from trying to recollect it and do something else; to our pleasant surprise that information automatically pops up into our mind after some time. This is because even if we stopped trying, the mind is searching for that information and brings it to awareness when it is found. Sometimes the information was blocked when we

wanted, and mind brings it forward when the blocking is removed. This is where stress plays its role in hindering recall.

If we are very anxious by nature or very stressful in nature, we may encounter this type of blockage very often. In such case, it is highly recommended that we practise some kind of relaxation technique and thus keep our anxiety and stress away. This is very important because this behaviour can bring many undesirable psychological and physiological conditions. We may even consult a clinical psychologist in extreme cases.

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3.12 NATURE OF FORGETTING: ARE MEMORIES PERMANENT?

Hermann Ebbinghaus (1913) was one of the first researchers to study forgetting. Because he did not want any verbal associations to aid him in remembering, he created several lists of 'nonsense syllables', pronounceable, but meaningless (such as, GEX and WOL). He memorized a list, waited a specific amount of time, and then tried to retrieve the list, graphing his results each time. The result has become a familiar graph—the curve of forgetting. This graph clearly shows that forgetting happens quickly within the first hour after learning the lists and then tapers off gradually. In other words, forgetting is greatest just after learning. Although meaningful material is forgotten much more slowly and much less completely, the pattern obtained when testing for forgetting is similar (Conway et al., 1992). Forgetting can be due to several reasons; some of them are as follows:

- **Encoding failure:** There are several reasons why people forget things. One of the simplest is that some things never get encoded in the first place. Researchers Nickerson and Adams, 1979, developed a test of encoding failure using images of pennies.
- **Memory trace decay theory:** A memory trace is some physical change in the brain, perhaps in a neuron or in the activity between neurons, which occurs when a memory is formed (Peterson and Peterson, 1959). Over time, if these traces are not used, they may decay, fading into nothing.
- **Interference theory:** A possible explanation of LTM forgetting is that although most long-term memories may be stored more or less permanently in the brain, those memories may not always be accessible to attempted retrieval because other information interfaces (Anderson and Neely, 1995).
- **Proactive interference:** The tendency for older or previously learned material to interfere with the retrieval of newer, more recently learned material
- **Retroactive interference:** When newer information interferes with the retrieval of older information, this is called retroactive interference.
- **Memory and the brain: the physical aspects of memory:** The physical change that takes place in the brain when a memory is formed is called the

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anagram. Researchers have evidence that specific areas of the brain may be the place in which anagram is formed and that these areas are different for different types of memory.

- **Neural activity and structure in memory formation:** The changes that take place as an engram forms are called consolidation. Although people may learn quickly, the memory of what has been learned takes some time to form completely.
- **When memory fails:** It is also referred to as organic amnesia. There are two forms of severe loss of memory disorders caused by problems in the functioning of the memory areas of the brain.
- **Retrograde amnesia:** Retrograde amnesia is a form of amnesia where someone is unable to recall events that occurred before the development of the amnesia (Hodges, 1994). This kind of memory loss occurs when consolidation process, which was busy making the physical changes to allow new memories to be stored, gets disrupted and loses everything that was not already nearly 'finished'.
- **Anterograde amnesia:** Anterograde amnesia is a loss of the ability to create new memories after the event that caused the amnesia, leading to a partial or complete inability to recall the recent past, while long-term memories from before the event remain intact (Squire and Slater, 1978). People with this kind of amnesia have difficulty remembering anything new and is often seen in people with senile dementia, a mental disorder in which severe forgetfulness, mental confusion, and mood swings are the primary symptoms.
- **Infantile amnesia:** Involves the type of memory that exists in the first few years of life, when a child is still considered an infant. Early memories tend to be implicit and implicit memories are difficult to bring to consciousness.

3.13 LANGUAGE AND THOUGHT

Why do some children build towers with blocks, cry when they scrape their knees, and shout and cry when a sibling takes away their favourite toy train? Why are some children able to perform entire piano concertos or master complex mathematical concepts, while others cannot even learn to communicate in the normal way? In short, why do humans behave the way they do? With the exception of identical twins, each new human being receives a novel combination of genes divided among forty-six chromosomes. Undoubtedly, this genetic material provides the basis for growth and development and, in doing so, places certain restrictions on the new infant. If the limiting action of genes seems disputable, think of how many people you know who grow to heights of more than twenty feet tall, live longer than two hundred years, or can run faster than a cheetah.

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Controversy does arise, however, when one tries to examine the extent of genetic influence on human behaviour. Just how many of our abilities and shortcomings are innate in nature, and how many are acquired through our interactions with the environment? This debate has been going on for centuries, and popular attitudes have varied greatly throughout this time. At one extreme, we have John Locke's idea of 'tabula rasa', which proposes that the minds of newborn infants are blank slates that will be differentiated and altered only through sensory experience. Modern biological determinism represents the other extreme. In its strictest form, this ideology suggests that behaviours are inherent and innate, resulting from the expression of genes. Most intellectuals subscribe to a view somewhere between these two extremes, on the gradient of a controversy that is still a hot topic of debate in many intellectual fields.

One particularly interesting field within the nature-nurture debate that has drawn heated testimony from both sides is language acquisition. How much of our ability to produce and comprehend language is programmed into our genes, and how much do we acquire only with environmental stimulus? Obviously, language cannot be completely genetic. Humans speak a wide variety of different languages, and very young children of any race or ethnic background can learn to speak and understand any of these if exposed to appropriate models at the proper time in development. Similarly, children cannot learn to speak a public language without this critical exposure. However, all humans use language in one form or another, and psychologists and linguists have noted many cross-lingual universals both in how children acquire language and in the inherent characteristics of the languages themselves. Therefore, as is the case with most aspects of human behaviour, the truth most likely lies in some combination of nature and nurture.

The ability to use language is a very important part of human cognition. In fact, some would argue that it is this ability which distinguishes us from other animals. Regardless of one's view of the capability of animals to use language or language-like symbols, the fact that humans have language abilities far superior to those of other animals cannot be ignored. Despite the ubiquity of human linguistic ability, pinning down exactly how language helps us and how we use it is not at all a straightforward task. One obvious use for public language is to communicate one's thoughts to other people. In fact, this may seem like the only, or at least the most important, use of our linguistic abilities. However, both Howard Gardner and Andy Clark stress other uses. Gardner, for example, lists four discrete uses for public language in his *Frames of Mind: The Theory of Multiple Intelligences*. These are as follows:

(i) People use language to induce action in other people. Examples of this might include a child asking a parent to hand him a toy that is on a high shelf or a boss sending a memo out to his employees asking them to hand in budget drafts by the next week.

(ii) Language can be used as a tool by one individual to help that individual remember things. In this way, language expands cognitive abilities that

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are already present in the human brain. For example, a child may not be able to remember how many days are in December or May, but by learning the rhyme that begins, 'Thirty days hath September' he will easily be able to store these facts in memory. Wearing nametags at a conference and making oral or written shopping lists are other examples of using language to aid memory.

(iii) The third use of language involves the transfer of explanations or knowledge from one person to another. For example, the parent teaching his child how to tie his shoes and the professor giving a lecture on ionic bonding both are using language to share their knowledge with another people. It is this use that can lead to cultural evolution.

(iv) The fourth discrete use of language is to talk about language itself, or as Gardner states, 'to use language to reflect upon language, to engage in metalinguistic analysis.'. A child asking his father what the word 'wish' means and a linguist examining the syntactic rules of various languages are both using this type of 'metalinguistic analysis'.

3.14 NATURE AND PROCESS OF THINKING

Thinking is manipulating information as when we form concept, solve problem, think critically reason and make decision. Different approaches describe thinking in different manner. They are as follows:

- **Associationist approach:** This approach suggests that thinking involves the reproduction of previously learned responses. The claim of the associationists is that human thinking follows along similar lines—that we will produce responses not through any complex internal representational processes, but as a result of associating a particular stimulus with a particular response.
- **Gestalt approach:** Gestalt believes thinking as cognitive restructuring. The Gestalt psychologists disagreed with the associationist viewpoint and considered thought to be more than simple associations. They suggested that a person could have insight into, say, a problem's structure and in order to solve the problem they will restructure it. This suggests that thinking through something involves having some insight into the structure of what we are trying to think about and then restructuring it in order to do something about it.

3.14.1 Forms of Thinking: Thinking as Adaptation

This idea suggests that thinking develops through adaptation to particularly skilful ways of dealing with problems. Anderson (1985) suggests that skill acquisition is a move from the use of declarative knowledge to procedural knowledge, so thinking will differ depending on the level of a person's skill and the demands of a particular task.

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According to Hudson, there are two different styles of thinking—convergent and divergent. They are as follows:

(i) **Convergent thinking:** Convergent thinking is problem-bound and is focussed on the limitations of the problem. It occurs when the individual has a tendency to work towards on a single right answer. It often involves some degree of functional fixedness where the person trying to solve a problem cannot view an object as serving any other purpose other than the one it usually serves. For example, if asked to think up as many uses as possible for a brick then the convergent thinker will tend to stay within the boundaries of the functions normally associated with a brick, such as building and construction.

(ii) **Divergent thinking:** This is the opposite of convergent thinking, it is not problem bound and does not focus on one single right answer. It is where the individual will move towards a more novel and original line of thought that might yield any number of possible solutions to a problem. For example, if a divergent thinker was asked to think up as many uses as possible for a brick they would be likely to come up with hundreds of possibilities, very few of which would conform with the usual uses (e.g., making a sandwich).

3.14.2 Symbols and Concepts as Different Components of Thought

Formation of concepts

Thought can be conceived of as a 'language of the mind'. Actually, there may be more than one language. One mode of thought corresponds to the stream of sentences that we seem to 'hear in our mind'. It is referred to as propositional thought because it expresses a proposition or claim. Another mode, imaginal thought, corresponds to images, particularly visual ones that we can 'see' in our minds. Figure 3.5 illustrates the various components of thought formation, starting from concept formation. The rest of the components of thought formation will be discussed later in the unit.

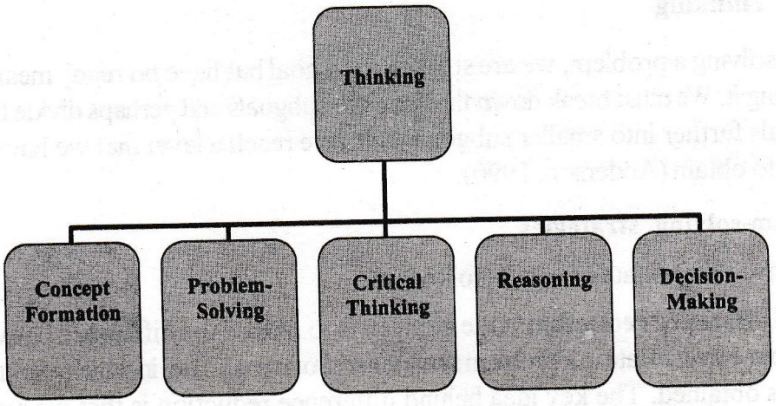

Fig. 3.5 Components of Thought

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Functions of concepts

The following are the functions:

- **A concept represents an entire class:** It is the set of properties that we associate with a particular class. Our concept of cat, for example, includes the properties of having four legs and whiskers. Concepts serve some major functions in mental life. One of those functions is to divide the world into manageable units (cognitive economy). The world is full of so many different objects that if we treated each one as distinct, we would soon be overwhelmed.
- **Concepts allow us to predict information:** It is not readily perceived (referred to as predictive power). For example, our concept of 'apple' is associated with readily perceived properties like being round, having a distinctive colour, and coming from trees. We may use the visible properties to categorize some object as an apple (the object is red, round, and hangs from a tree) and then infer that the object has the less visible properties as well (it has seeds and is edible). Concepts enable us to go beyond directly perceived information (Anderson, 1991; Bruner, 1957).

These kinds of goal-driven concepts facilitate planning. Although such concepts are used relatively infrequently, and accordingly have relatively long names, they still provide us with some cognitive economy and predictive power (Barsalou, 1985).

Prototypes

The properties associated with a concept seem to fall into two sets. One set of properties make up the prototype of the concept. They are the properties that describe the best examples of the concept. In the concept 'grand mother,' for example, our prototype might include such properties as a woman who is in her 60s, has gray hair, and loves to spend time with her children.

3.14.3 Problem-Solving, Reasoning, Decision-Making and Creative Thinking

When solving a problem, we are striving for a goal but have no ready means of obtaining it. We must break down the goal into subgoals and perhaps divide these subgoals further into smaller subgoals, until we reach a level that we have the means to obtain (Anderson, 1990).

Problem-solving strategies

Problem-solving strategies are as follows:

- **Difference reduction:** One strategy is to reduce the difference between our current state in a problem situation and our goal state, in which a solution is obtained. The key idea behind difference reduction is that we set up subgoals which put us in a state that is closer to our goal.

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- **Means-ends analysis:** A similar but more sophisticated strategy is means-ends analysis. We compare our current state to the goal state in order to find the most important difference between them, and eliminating this difference becomes our main subgoal. Means-ends analysis is more sophisticated than difference reduction because it allows us to take action even if it results in a temporary decrease in similarity between our current state and the goal state
- **Work backward:** Another strategy is to work backward from the goal, a particularly useful strategy in solving mathematical problems.

These three strategies, viz., difference reduction, means-ends analysis, and working backward are very general and can be applied to any problem. Steps in problem solving are as follows:

- Represent the problem as a proposition or in visual form.
- Determine the goal.
- Break down the goal into subgoals.
- Select a problem-solving strategy and apply it to achieve each subgoal.

Representing the problem

Being able to solve a problem depends not only on our strategy for breaking it down, but also on how we represent it. Sometimes a propositional representation works best, and at other times a visual representation or image is more effective. In trying to solve this problem, many people start with a propositional representation. They may even try to write out a set of equations. The problem is far easier to solve when it is represented visually. Some problems can be readily solved by manipulating either propositions or images.

Experts versus novices

Experts and novices also differ in the strategies they employ. In physics, while soling problems, experts generally try to formulate a plan for attacking the problem before generating equations, whereas novices typically start writing equations with no general plan in mind (Simon and Simon, 1980). Another difference is that experts tend to reason from the given problem toward a solution, but novices tend to work in the reverse direction (the working-backward strategy). This difference in the direction of reasoning has also been found in studies of how physicians solve problems. More expert physicians tend to reason in a forward direction—from symptom to possible disease—but the less expert tend to reason in a backward direction—from possible disease to symptom (Patel and Groen, 1986).

The characteristics of expertise, multitude of representations, principle based representations, planning before acting, and working forward are the specific procedures that come to dominate the weak methods of problem-solving discussed earlier.

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Heuristics

A heuristic is a short-cut procedure that is relatively easy to apply and can often yield the correct answer, but not inevitably so. People often use heuristics in everyday life because they have found them useful. However, they are not always dependable. People use the similarity heuristic because similarity often relates to probability yet is easier to calculate. Use of the similarity heuristic also explains why people ignore base rates.

Critical thinking

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analysing, synthesizing, and/or evaluating information.

People who think critically and consistently generally tend to live rationally, reasonably and empathically. They use the intellectual tools that critical thinking offers—concepts and principles that enable them to analyse, assess, and improve thinking. Critical thinking is, in short, self-directed, self-disciplined, self-monitored, and self-corrective thinking. It presupposes assent to rigorous standards of excellence and mindful command of their use. It entails effective communication and problem-solving abilities and a commitment to overcome our native egocentrism and sociocentrism (Paul and Elder, 2008).

Reasoning

Reasoning is the mental activity of transforming information to reach conclusion. It is a skill closely tied to critical thinking (Markman and Gentner, 2001). When we think in terms of propositions, our sequence of thoughts is organized. The kind of organization of interest to us here manifests itself when we try to reason. In such cases, our sequence of thoughts often takes the form of an argument, in which one proposition corresponds to a claim, or conclusion, that we are trying to draw. The remaining propositions are reasons for the claim or premises for the conclusion. Reasoning can be either inductive or deductive, as follows:

(i) **Deductive reasoning:** Deductive reasoning is reasoning from the general to specific (Newstead and others, 2002). Initial rules of assumptions are true, the conclusion will follow directly as a matter of logic; for example, (i) If it is raining, (ii) I will take an umbrella, (iii) Its raining (iv) Therefore, I will take an umbrella.

Some theories of deductive reasoning assume that we operate like intuitive logicians and use logical rules in trying to prove that the conclusion of an argument follows from the premises. For example, consider the rule that we have a proposition of the form 'if p then q', and another proposition p, then we can infer the proposition q.

Effects of content

Logical rules do not capture all aspects of deductive reasoning. Such rules are triggered only by the logical form of propositions, yet our ability to evaluate a deductive argument often depends on the content of the propositions as well.

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(ii) **Inductive reasoning:** Inductive reasoning is the reasoning from the specific to general (Coley and others, 2004). An example can illustrate this better. Many psychologists accept the logician's distinction between deductive and inductive reasoning, but not all do. Some researchers who believe that mental models underlie deductive reasoning further hold that mental models are used in inductive reasoning and that consequently there is no qualitative difference between deductive and inductive reasoning.

Decision-making

Decision-making involves evaluating alternatives and making choices among them. For example, 'Should I major in psychology, or history?', 'Should I go to a job or for study?' In studying decision-making, researchers make their studies more tractable by replacing such complex options with options that contain just the essential information. When we make decision, rules are not established, and we do not know the consequences of the decision (Tversky and Fox, 1995). Some of the information might be missing, and we might not trust all of the information we have (Matlin, 2004). Other mistakes we are prone to make in weighing our options are confirmation, belief perseverance, overconfidence bias, hindsight bias, availability heuristic, representative ness heuristic (Santovich, 2004).

Recently, researchers have discovered that neurological patients with brain damage in a particular part of the frontal lobes have problems making good decisions (ones that maximize utility), even though they have retained normal intelligence, language, and memory. That area of the frontal lobes is referred to as the ventrolateral prefrontal cortex. It includes an area that fifty years ago was thought to underlie personality and was sometimes the target of 'frontal lobotomies' in mental patients (a dubious surgical procedure that is no longer used). Rather than the 'seat of personality', the ventrolateral cortex is now seen as involved in decision-making, and studies of ventrolateral patients have begun to inform us about the neural bases of decision-making.

All the components of thought that have been mentioned are illustrated in Figure 3.5.

Creative thinking

Creativity refers to the phenomenon whereby a person creates something new (a product, a solution, a work of art, etc.) that has some kind of value. What counts as 'new' may be in reference to the individual creator, or to the society or domain within which the novelty occurs. What counts as 'valuable' is similarly defined in a variety of ways.

Scholarly interest in creativity ranges widely; the relationship between creativity and general intelligence, the mental and neurological processes associated with creative activity; personality type and creative ability, creativity and mental health, creativity in education, and ways of fostering creativity through training and technology.

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Creativity and creative acts are therefore studied across several disciplines—psychology, cognitive science, education, philosophy (particularly philosophy of science), technology, theology, sociology, linguistics, business studies, and economics. As a result, there is a multitude of definitions and approaches.

3.15 UNDERSTANDING LANGUAGE ACQUISITION

Language is our primary means of communicating our thoughts. Everyone can master and use an enormously complex linguistic system.

3.15.1 Development and Levels of Language

Language use has two aspects—production and comprehension. In the production of language, we start with a thought, somehow translate it into a sentence, and end up with sounds that express the sentence. In the comprehension of language, we start by hearing sounds, attach meanings to the sounds in the form of words, combine the words to create a sentence, and then somehow extract meaning from it. Language use seems to involve moving through various levels. At the highest level are sentence units, including sentences and phrases. The next level is that of words and parts of words that carry meaning (the prefix or the suffixes, for example).

The lowest level contains speech sounds; the adjacent levels are closely related. The phrases of a sentence are built from words and prefixes and suffixes, which in turn are constructed from speech sounds. Language is therefore a multilevel system for relating thoughts to speech by means of word and sentence units (Chomsky, 1975). The following are the levels of language

- **Speech sounds:** We would not perceive the person's speech as a continuous stream of sound but rather as a sequence of phonemes, or discrete speech categories. For example, the sound corresponding to the first letter in 'boy' is an instance of a phoneme symbolized as 'b'. Every language has a different set of phonemes. When phonemes are combined in the right way, we perceive them as words. Each language has its own rules about which phonemes can follow others.
- **Word units:** Unlike phonemes, words carry meaning. However, they are not the only small linguistic units that convey meaning. Suffixes. such as 'ly' or prefixes such as 'un' also carry meaning. They can be added to words to form more complex words with different meanings. The term morpheme is used to refer to any small linguistic unit that carries meaning. The most important aspect of a word is its meaning. Some words are ambiguous because they name more than one concept.
- **Sentence units:** As listeners, we usually combine words into sentence units, which include sentences as well as phrases. An important property of these units is that they can correspond to parts of a thought, or proposition. Such correspondences allow a listener to extract propositions from sentences.

- **Phrases and propositions:** Analyzing a sentence into noun and verb phrases, and then dividing these phrases into smaller units like nouns, an adjective, and verbs, is syntactic analysis. Syntax deals with the relationships between words in phrases and sentences. Syntax primarily serves to structure the parts of a sentence.

3.15.2 Roots of Language and its Use

Development occurs at all three levels of language. It starts at the level of phonemes, proceeds to the level of words and other morphemes, and then moves on to the level of sentence units, or syntax.

Phonemes and combinations of phonemes

Although children learn which phonemes are relevant during their first year of life, it takes several years for them to learn how phonemes can be combined to form words. When children first begin to talk, they occasionally produce difficult words like dumber for lumber. By age four, however, children have learned most of what they need to know about phoneme combinations.

Words and concepts

At about one year of age, children begin to speak. One-year-olds already have concepts for many things (including family members, household pets, food, toys, and body parts), and when they begin to speak, they are mapping these concepts onto words that adults use. The beginning vocabulary is roughly the same for all children. Children who are 1 to 2 years old talk mainly about people (dada, mama, baby, etc.). Thereafter, the child's vocabulary development virtually explodes. At a year and a half, a child might have a vocabulary of twenty-five words, at six years, the child's vocabulary grows; children have to learn new words at the rate of almost ten per day (Miller and Gildea, 1987). Children seem to be attained to learning new words.

From primitive to complex sentences

Between the ages of a year and a half and two and a half years, the acquisition of phrase and sentence units, or syntax begins. Children start to combine single words into two-word utterances. Children progress rapidly from two-word utterances to more complex sentences that express propositions more precisely.

Learning process

Innate factors must also play a role. That is why children raised in English-speaking households learn English where as children raised in French-speaking households learn French.

Imitation and conditioning

One possibility is that children learn language by imitating adults. Although imitation plays some role in the learning of words (a parent points to a telephone says, 'phone' and the child tries to repeat the word), it cannot be the principal means by