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ANATOMICAL AND PHYSIOLOGICAL UNDERSTANDING OF SMRITI (MEMORY) IN PURVIEW OF AYURVEDA- A SYSTEMATIC REVIEW

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ABSTRACT

Smriti plays an important role in the existence of an individual. In Ayurveda, it is mentioned that recollecting the things which are observed, heard and experienced is called *smriti*. The ability to remember and learn are among the most fundamental and significant of our brain's abilities. Not only does the brain permit us to experience everything around us, it allows us to re-experience our past. It does this in several ways, using distinct types of memory. Learning is the process by which new experiences are acquired and integrated with previous experience. Memory is the ability to recall past events like facts, objects, people etc. It also implies the ability to recognize events or objects etc. Recognition is easier than recall. Memory is closely associated with learning. Memory is the retention and storage of the information. The brain receives various amount of information from various sense organs, but it does not have the capacity to store all the information received nor it is necessary to do so. So, most of the information received which is not of use are just suppressed, while those which are considered useful are retained as memory. Synaptic events have an important role and form a basis of learning process and memory.

KEYWORDS: Smriti, Memory, Ayurveda, Learning.

INTRODUCTION

Learning is the ability to acquire new information or skills through instruction or experience. Learning is the process by which new experiences are acquired and integrated with previous experience. It is the acquisition of knowledge and skills. The nervous system appears essential for the process. Complex learning requires the cortex, but some forms of learning are present in lower forms of life and subcortical structures take part in the process. Hippocampus is considered necessary for intellectual learning but probably not for learning physical skills.[1] Memory is the process by which information is acquired through learning is stored and retrieved. For an experience to become a part of memory, it must produce persistent structural and functional changes that represent the experience in the brain. This capability for change associated with learning is termed plasticity. Nervous system plasticity underlies our ability to change our behaviour in response to stimuli from the external and internal environments. The parts of brain known to be involved with memory include the association areas of the frontal, parietal, occipital and temporal lobes. Part of limbic system, especially the hippocampus and amygdala and the diencephalon. Memory is closely associated with learning, but the physiological basis of memory is also not well understood.[2]

Ayurvedic Aspect of Memory (*Smriti)*

A memory is nothing but the remembrance of things which are directly perceived, heard or experienced earlier.[3] Various scattered references about the concept of smriti can be found in our classical texts of Ayurveda. Memory(smriti) is very much related to Buddhi(intellect) and Mana(mind). The power of mind to retain and reproduce is termed as memory. The efficacy of the memory varies according person to person. *Smriti* is that which results from a particular conjunction between the soul and mind and also from impression. According to our classical texts, recollecting the things which are observed, heard and experienced is called *smriti.* Memory comprises of an important facet of knowledge and *Gyana grahana.* Proper *Gyana grahana* is primarily essential for smriti in a person. *Gyana grahana* process can only happen due to proper synchronization between *Atma, mana, indriyas and indriyartha.* When the *mana* is fatigued or when proper *indriya* and *indriyartha sannikarsha* is not working properly *Gyana grahana* process will be hampered or disturbed. Improper *Gyana grahana* will lead to improper understanding and improper retention of things. Thereby affecting the memory of the person. The conjugation of *atma, indriya and mana* lead to *pratyakshgyana.*[4]

If the manifestation is not instantaneous, the resultant mental faculty may not lead to perception because interference which arises out of the perception and memory in which the proximity of the soul, sense faculty, mind and objects is obtained by imagination do not come under the category of perception. The regimen prescribed beginning with devotion to the noble persons and ending with the absolute mental control serve as an aid to good memory. If one only remembers the real nature of things, he gets rid of miseries.[5]

Nyaya darshana also defines so many causes as the base of memory. It depends on the power of retention, recall of the event etc. and its recognition. Any impression remains is memory according to its recency, frequency, interest and association. Reminiscence results from a particular conjunction between the soul and the mind and also from impression or retention. Good memory increases the efficacy of an individual. Memory is the base of imaginations and thoughts. Man is thought to be intellectual due to the power of remembrance as the old experiences remain with him as impressions. Lack of memory leads to the loss of knowledge (*buddhi*) which may destroy the individual. *Pratyaksha* (direct perception) is very essential for the process of *Smriti*. *Acharya Charaka,* in the definition of *pratyaksha* clearly says that a mental faculty instantaneously manifested as a result of proximity of soul, sense faculties, mind and object is known as perception or direct observation. Perception, according to *Nyaya Darshana*, is the direct and immediate cognition produced by the interaction between the object and sense organs.

Essential Factors for Memory- The remembrance of any experienced knowledge is based on three basic steps or factors. They are retention, recollection and recognition.

Retention- The impressions of our past experiences are retained in the mind. The retention capacity in different persons may differ in individuals and depends upon recency, frequency, interest and association.

Recall- The impressions of the mind are recalled or recollected by the different impulses.

Recognition- The recollection of old impressions leads to the recognition of particular person (or subject) and the memory is established.[6]

Causes of Memory (*Smriti*)

In medical science, memory is a very important factor. Good memory has been accepted as one of the qualities of the patient. The physician collects the knowledge about causes,

symptoms and treatment of the diseases and uses the knowledge retained in the mind by the quality of memory. Impairment of intellect, patience and memory are known as *pragyaparadha* and are considered to be the causative factors for miseries. Memory is impaired due to a person being overcome by *rajas* and *tamas doshas.*

Power of Memory (*Smriti*) for Salvation- The power of metaphysical memory constitutes the best way of liberation, as shown by the liberated ones. Persons following this way do not come back to worldly traps. This is the best way to attainment of *yoga* as well as *moksha.*[7] Attainment of salvation (*moksha)* thought to be the ultimate goal of an individual. *Charaka* emphasizes that this can be attained by the virtue of the constant memory of the fact that the soul is different from the body and latter has nothing to do with the former and if one only remembers the real nature of things, he gets rid of miseries. Thus, memory has its important utility in the field of physical as well as spiritual ailments.

Factors Responsible for *Smriti*

According to acharya Charaka, there are two main factors which are responsible of smriti. They are

a) *Abhyantara Karana*

b) *Bahya Karana*

Abhyantara Karana- The *sannikarsha* of *atma*, *mana*, *indriya* and *indriyartha* are responsible for *smriti*.

Table 1: Bahya Karana

According to acharya Charaka, there are 8 factors which brings about good memory.[8]

1. ***Nimitta grahana***	Knowledge of cause
2. ***Rupa grahana***	Knowledge of form
3. ***Sadrishyata***	Knowledge of similarity
4.***Viparyaya***	Knowledge of contrast
5. ***Sattvanubandha***	Concentration of mind
6. ***Abhyasa***	Repetition of same object
7. ***Gyana yogata***	Attainment of metaphysical knowledge
8. ***punaha shrutata***	Subsequent partial communication of an event

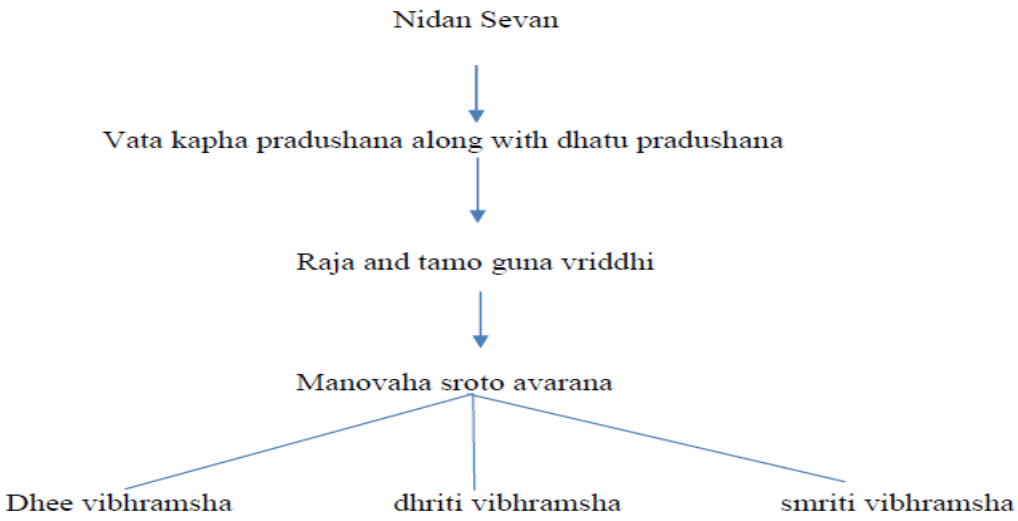
Impairement of Memory

It is derangement of memory (*smriti vibhramsha*). If memory is impaired due to a person being overcome by *rajas* and *tamas*, this is known as the impairment of memory (*smriti vibhramsha)*. Normally memory contains everything memorable. It is the cause of all sort of psychological disorders later may end up with psycho-somatic disorders.

JARA- In old age (*jara)* lasting up to 100th year of age, there is a gradual diminution of dhatus (tissue elements), *indriyas* (strength of sense organs), *bala* (energy), *grahana shakti* (power of understanding), *dharana* shakti (retention), *smarana* shakti (memorising). This is due to depletion of *dhatus* and aggravation of *vata dosha* during this age.[9]

Pathogenesis of Smriti Vibhramsha

Smriti vibhramsha is nothing but derangement of memory. when on covering of the self by rajas and tamas the recollection of the knowledge of reality is unpaired, it is known as *Smriti vibhramsha*.



Smriti vibhramsha and *smriti nasha* leads to various psychological disorders like *Apasmara* (epilepsy), *unmada* (insanity) etc.

Role of *Prajnaparadha*

'Prajnaparadha' is defined as perversion of *dhee*, *dhriti* and *smriti* resulting in defective decision making and inability in controlling mind from harmful objects.

A person whose intellect, fortitude and memory are impaired, subjects himself to intellectual blasphemy by virtue of his bad actions leading to the aggravation of all *doshas.*[10] In *Charaka Samhita* the causes of *manovikaras* like *irshya*, *shoka*, *bhaya*, *krodha*, *mana* and *dvesha* are attributed to the defects in the intellectual or mental faculty of the person.

Anatomical Aspect of Memory

The Limbic Network for Memory

The word "limbic" means "border". Originally, the term "limbic" was used to describe the border structures around the basal regions of the cerebrum, the term limbic system has been expanded to mean the entire neuronal circuitry that controls emotional behaviour and motivational drive.[11] Limbic and paralimbic areas (such as the hippocampus, amygdala and entorhinal cortex), the anterior and medial nuclei of the thalamus, the medial and basal parts of the striatum and the thalamus collectively constitute a distributed network known as the limbic system. The behavioural affiliations of this network include the coordination of emotion, motivation, autonomic tone and endocrine function. An additional area of specialization for the limbic network and the one which is of most relevance to clinical practice is that of declarative (conscious) memory for recent episodes and experiences. A disturbance in the function is known as an amnestic state. Although the limbic network is the site of damage for amnestic states, it is almost certainly not the storage site for memories. Memories are stored in widely distributed form throughout the cerebral cortex. The role attributed to the limbic network is to bind these distributed fragments into coherent events and experiences that can sustain conscious recall. Damage to the limbic network does not necessarily destroy memories but interferes with their conscious (declarative) recall in coherent form. The individual fragments of information remain preserved despite the limbic lesions and can sustain what is known as implicit memory. One of the functions of limbic system is memory and learning (hippocampus).

Role of Specific Parts of the Brain in the Memory Process

Hippocampus promotes storage of Memories- The hippocampus is the most medial portion of the temporal lobe cortex where it folds first medially underneath the brain and then upward into the lower, inside surface of the lateral ventricle.[12] Bilateral removal of the hippocampus impairs the memory. Remote memory is intact as previously learned activities can be performed satisfactorily. But new memories last only for seconds and there is anterograde amnesia. Inability to store new memories impairs learning process. Hippocampus is thus concerned with storing of memory trace and consolidation of long-term memories and is helpful in learning process.

Diencephalon- It is a division of the forebrain and is situated between the telencephalon and the midbrain. It is the middle structure which is largely embedded in the cerebrum. Its cavity

forms the greater part of the third ventricle. The hypothalamic sulcus, extending from the interventricular foramen to the cerebral aqueduct, divides each half of the diencephalon into dorsal and ventral parts.[13] Below the hypothalamic groove the side walls slopes down to the floor. This region including the floor, is the hypothalamus.

Dorsal part of diencephalon

Thalamus- It is a large mass of grey matter situated in the lateral wall of the third ventricle and in the floor of the central part of the lateral ventricle. It has anterior and posterior ends; superior, inferior, medial and lateral surfaces.[14]

Metathalamus- It consists of medial and lateral geniculate bodies, which are situated on each side of the midbrain, below the thalamus.[15]

Epithalamus – It occupies the caudal part of the roof of the diencephalon and consists of the pineal body and habenula.[16]

Ventral part of diencephalon

Hypothalamus- It is a part of the diencephalon. It lies in the floor and lateral wall of the third ventricle. It has been designated as the head ganglion of the autonomic nervous system because it takes part in the control of many visceral and metabolic activities of the body. Anatomically it includes the floor of the third ventricle, or structures in the interpeduncular fossa and the lateral wall of the third ventricle below the hypothalamic sulcus.[17]

Subthalamus (ventral thalamus)- It lies between the midbrain and thalamus, medial to internal capsule and the globus pallidus. It consists of grey matter and white matter.[18]

Amygdala- It is one of two almond-shaped groups of nuclei located deep and medially within the temporal lobes of the brain in complex vertebrates, including humans. It performs a primary role in the processing of memory, decision-making and emotional responses including fear, anxiety and aggression. It is a part of the limbic system.

Physiological Aspect of Memory

Physiologically, memories are stored in the brain by changing the basic sensitivity of synaptic transmission between neurons as a result of previous neural activity. The new or facilitated pathways are called memory traces. They are important because once the traces are established, they can be selectively activated by the thinking mind to reproduce the

memories.[19]

Classification of Memory

Memory may be classified as

1. Short term memory
2. Long term memory

Short Term Memory

a) One that lasts only for few seconds or a minute or two. For e.g. when one looks up a new telephone number and dials and thereafter the number is forgotten, so that one has to check the number again in order to make another call with the same number. It is called as working memory as it lasts for a few seconds.

b) Some short-term memory lasts for a few minutes or hours. Short term memory may be due to repeated oscillations set up in the cortex by sensory signals. When these are fatigued or when new signals arrive and interfere with them, the memory fades away. Synaptic events occur at the presynaptic terminal with Ca++ accumulation in this part and release of transmitter. This results in facilitation or inhibition.[20]

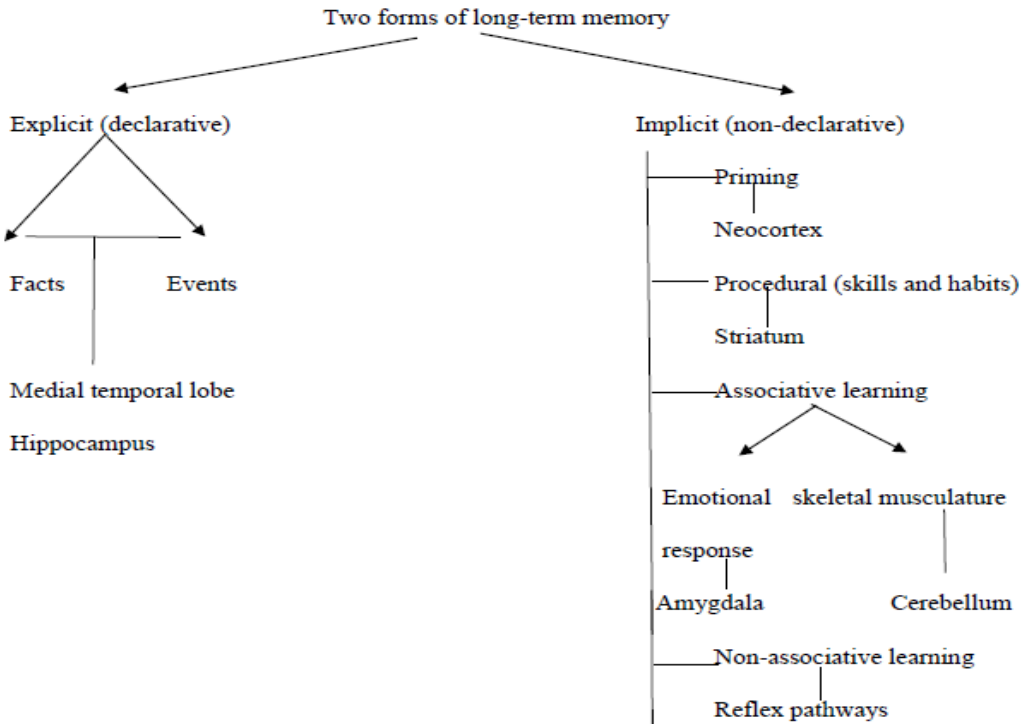
Long Term Memory

- Intermediate long-term memory
- True long-term memory

a) Intermediate long-term memory- It lasts for hours, days or weeks and is thereafter lost. For e.g. some facts memorized in preparation for an examination lasts some days or weeks. In this type of memory, temporary chemical or physical changes occur in the pre- as well as post synaptic terminal. A sensory terminal has a facilitator terminal on its surface. When both are activated simultaneously, facilitator terminal causes the release of serotonin in the sensory terminal. This acts via adenylate cyclase and cAMP, blocking K+ channels in the sensory terminal, which results in prolongation of the action potentials reaching sensory terminals. This permit increase in Ca++ entry in the sensory terminal, with increased neurotransmitter release and facilitation of transmission at the synapse. The duration of this type of memory can be prolonged by repetition. For e.g. by restudying, revising or recapitulating facts learned, one can keep them in memory for a long period. Memory that lasts for minutes, hours or days is recent memory.

b) True long-term memory- It lasts for several years and even for life time. An individual normally remembers his name, age, date of birth and some landmark events for life time and also some arithmetical facts such as addition and subtraction of numbers and multiplication tables. Some important events and facts are remembered for several years.[21]

Forms of long-term memory[22]



Consolidation and Storage of Memory

Consolidation is a process by which structural and chemical changes necessary for long term memory are brought about. Memory stored in this way is called "Engram". Memory is due to changes that occur at the synapses, resulting in the formation of new pathways, referred to as memory trace. For conversion of short memory to long memory, consolidation is necessary. It is estimated that minor consolidation needs 5-10 minutes while strong consolidation requires an hour or more. Rehearsal or repetition of the same information again and again facilitates the process of consolidation.[23]

Structures Involved In Memory

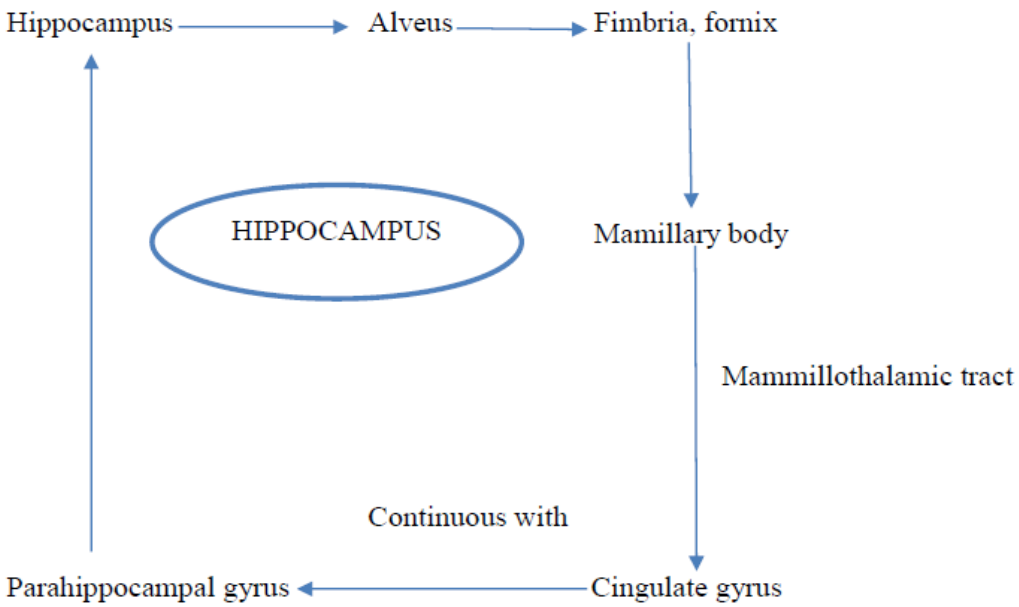
The structures involved in memory include the following:

(i) Several parts of the cerebral cortex especially the association areas of the parietal, occipital and frontal lobes. When a person tries to remember the sequence of several numbers and

isrehearsing it in the mind (working memory) there is increased activity in the association areas of the brain.

(ii) Hippocampus, the Para hippocampal gyrus, the perirhinal and entorhinal cortex. The hippocampus is not essential for working memory nor for some form of reflexive memory. Bilateral removal of the hippocampus impairs memory. Remote memory is intact as previously learned activities can be performed satisfactorily. But new memories last only for seconds and there is anterograde amnesia. Inability to store new memories impairs learning process. Hippocampus is thus concerned with storing of memory traces and consolidation of long-term memories and is helpful in learning process. Hippocampus is necessary for recent memory that can be translated into long term memory. Hippocampal lesion impairs recent memory and not remote memory.

Hypothalamus and thalamus are also involved in memory, by virtue of their connections with the hippocampus. The mamillary bodies receives fibres from the hippocampus via the fornix, and connect via the mamillo thalamic tract to the anterior nucleus of the thalamus, from where fibres project to the cingulate gyrus.[24]



Flow chart 1: Hippocampus.[25]

Disorders of Memory

Amnesia- It is impairment or loss of memory. An inability to recall previously known facts or events is called retrograde amnesia. Inability to learn new facts or acquire new memories is

called anterograde amnesia. Among the conditions in which amnesia occurs are lesions of the hippocampus, diencephalic structures, temporal lobe lesions, head injuries, degenerative diseases of the brain (Alzheimer's disease), chronic alcoholism (Korsakoff's psychosis) and severe hypoxia. Usually bilateral lesions cause amnesia, but severe unilateral lesions involving the dominant hemisphere may also cause amnesia. Amnesia is often temporary and affects recent memory rather than remote memory. In head injuries there is for some time a retrograde amnesia with an inability to recall events immediately preceding the injury while remote memory is not affected. In hippocampal lesions there is some retrograde amnesia for recent events along with anterograde amnesia. Loss of memory occurs in senile and presenile dementia. In dementia there is not only a failing memory but also loss of most intellectual functions, behavioural abnormalities and personality changes.[26]

Alzheimer's Disease- It is also called as senile dementia. It is a chronic neurodegenerative disease that usually starts slowly and worsens over time. A progressive disease that destroys memory and other important mental functions. It is characterized by degeneration and disappearance of neurons in the cerebral cortex, starting in the parietal lobe and spreading to the frontal and temporal lobes. There are present intracellular tangled masses called neurofibrillary tangles made up of some protein material and are believed to be responsible for causing degeneration and death of neurons. There are extracellular plaques called senile plaques or neuritic plaques made up of beta-amyloid protein.[27]

CONCLUSION

Memory plays a huge in our life. It plays a very important role in the existence of an individual It is very essential and indispensable requirement and need to gain knowledge in a person's life. It allows us to remember the skills which we have learnt, recall previous and precious incidences, stores information in the brain. Without a good memory a person is nothing. Our classical texts have described various importance of memory. Ayurvedic texts has mentioned importance of smriti in attainment of knowledge. In various diseases of brain, memory of the person gets affected and leads to derangement of memory. For diagnosing various diseases related to brain, memory plays an essential role in clinical practices.

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