Chapter VI: Human Memory

Part I: Introduction to Human Memory

1. Definition

Memory is defined as the faculty of the mind by which information is encoded, stored, and retrieved (Atkinson & Shiffrin, 1968). Memory is vital to experience. Without memory, we are not us. If we could not remember past events, we could not learn or develop language, relationships, nor personal identity (Eysenck, 2012).

2. Components of memory

Often memory is understood as an informational processing system with explicit and implicit functioning that is made up of a sensory processor, short-term (or working) memory, and long-term memory (Baddely, 2007).

2.1. Sensory memory

Sensory memory represents the initial stage of stimuli perception. It is associated with the senses, and there seems to be a separate section for each type of sensual perception, each with its own limitations and devices. Obviously, stimuli that are not sensed cannot be further processed and will never become part of the memory store. This is not to say that only stimuli that are consciously perceived are stored; on the contrary, everyone takes in and perceives stimuli almost continuously. It is hypothesized, though, that perceptions that are not transferred into a higher stage will not be incorporated into memory that can be recalled.

2.1.1. Types of Sensory memory
There are three types of sensory memories:

1) **Iconic memory** is a fast decaying store of visual information; a type of sensory memory that briefly stores an image which has been perceived for a small duration.

2) **Echoic memory** is a fast decaying store of auditory information, another type of sensory memory that briefly stores sounds that have been perceived for short durations.

3) **Haptic memory** is a type of sensory memory that represents a database for touch stimuli.

The transfer of new information quickly to the next stage of processing is of critical importance, and sensory memory acts as a portal for all information that is to become part of memory. This stage of memory is temporally limited which means that information stored here begins to decay rapidly if not transferred to the next stage. This occurs in as little as ½ second for visual stimuli and three seconds for auditory stimuli. There are many ways to ensure transfer and many methods for facilitating that transfer. To this end, attention and automaticity are the two major influences on sensory memory, and much work has been done to understand the impact of each on information processing.

2.2. Short-term memory

The second stage of information processing is the working or short-term memory. This stage is often viewed as active or conscious memory because it is the part of memory that is being actively processed while new information is being taken in. Short-term memory has a very limited capacity and unrehearsed information will begin to be lost from it within 15-30 seconds if other action is not taken. There are two main ways that are effective in processing information while it is in short-term memory. Rote or maintenance rehearsal is the first but less desirable of these methods. This type of rehearsal is intended only to keep information until it can be processed further. It consists mainly of some sort of repetition of the new information, and if it is not processed further will be lost. In fact, studies on the limitations of working memory have revealed a specific number of units that the mind can process at any given time, and it is now generally accepted that 5 +2 is the maximum number of stimuli that can be processed at once. There are several types of activities that one can perform to encode new information, but the importance of encoding cannot be overstated. Maintenance rehearsal schemes can be employed to keep information in short-term memory, but more complex elaboration is necessary to make the transfer to

long-term memory. It is absolutely necessary for new information to somehow be incorporated into the memory structure in order for it to be retained. There are many suggested models for encoding, but there are basically three ways in which retention occurs. A stimulus can be an almost exact match with existing structures in which case it would be simply added to the mental representation and no change would be made to the structure except its addition. If the new stimulus does not exactly match the existing structure, the structure itself would be adapted to allow for additional characteristics or definitions in which case there would be a fundamental change to the existing structure, which would broaden the defining structures.

Finally, if the new stimulus were vastly different from any existing structure, a totally new one would be created in memory. This new structure could in some way be linked to relevant structures, but it would stand alone as a new unit. At any rate, the incoming information must be acted on and through existing structures and incorporated into those systems in some way for acquisition to occur. The processing of this new stimulus takes place inshort-term memory, and the body with which the information is worked is the long-term memory.

2.3. Long-term memory

As discussed with short-term memory, long-term memory houses all previous perceptions, knowledge, and information learned by an individual, but it is not a static file system that is used only for information retrieval. Abbot (2002) suggests that long-term memory "is that more permanent store in which information can reside in a dormant state – out of mind and unused – until you fetch it back into consciousness" (p. 1). Inorder to incorporate new information, long-term memory must be in communication with short-term memory and must be dynamic. There are several categories of long-term memory, and there are many suggestions as to how memory units are represented in the mind. While it seems that it might be sufficient to understand simply that there are individual units and structures that exist in long-term memory, the specific way or ways that information is stored offers extremely important information. If the knowledge unit is pictorial rather than verbal, for example, it would seem to make sense that images would be more easily and readily stored in memory. If

the reverse were true, information should be presented in verbal constructs. This oversimplifies the problem, but it is this question that is at the core of the controversy over memory storage structures. There are two divisions at issue in the discussion of long-term memory: the types of long-term memory and the type of knowledge unit stored in long-term memory.

2.3.1. Organizations of long-term memory

Today cognitive psychologists believe that there are at least different types of information stored in long-term memory. Each of the memory structures is distinct and serves a different operational function. However, it is evident that some type of very specialized categorization system exists within the human mind. One of the first to make this idea explicit was Bruner (as cited in Anderson, 1996). "Based upon the idea of categorization, Bruner's theory states 'To perceive is to categorize, to conceptualize is to categorize, to learn is to form categories, to make decisions is to categorize" (p. 1).

Tulving (1972) was the first to distinguish between **episodic** and **semantic** memory, and all discussions recognize these two distinct types. Most researchers now combine these two in a broader category labeled declarative. Other researchers have identified additional organizational types. For example, Abbott lists declarative and procedural while Huitt (2000), citing the work of Paivio (1969) adds imagery to this list. However, Pylyshyn (2006) states that imagery is not a distinct organizational structure, but follows the rules that apply to semantic and episodic memory.

Abbott (2002) defines declarative memory in similar terms. He refers to declarative memory as that which can be talked about or verbalized. It is, then, the sum of stored information that can be readily retrieved and put into words inconscious thought and sharing. As previously stated, declarative memory can be subdivided into both semantic and episodic memories. These two subtypes are radically different although they can each be fairly easily recalled and manipulated. Episodic memory's store is centered on personal experience and specific events. It is entirely circumstantial and it is not generally used for the

processing of new information except as a sort of backdrop. "Episodic memories are those which give a subject the sense of remembering the actual situation, or event" (Eliasmith, 2001). This type of memory is somewhat like a personal video of a specific significant day or event, and its parts are not easily disseminated to characteristics or concepts.

Semantic memory, in contrast, deals with general, abstract information and can be recalled independently of how it was learned. It is semantic memory that is the central focus of most current study because it houses the concepts, strategies and other structures that are typically used for encoding new information. Procedural memory can be thought of as "how to" knowledge (Huitt, 2000 p. 4). It is the type of long-term memory sometimes associated with information that has reached a state of automaticity, but it not limited to this. This type of memory is defined in terms of learned skills and the ability to recall instruction-like memory. Paivio (1969) describes imagery as the memory structure for collecting and storing information related to pictures. It captures information much like a photograph and can be extremely useful for context and visual presentation of information.

3.   Models of Memory

Models of memory provide abstract representations of how memory is believed to work. Below are the multi-store model, and the working memory model.

3.1.   The multi-store model

The multi-store model (also known as Atkinson–Shiffrin memory model) was first described in 1968 by Atkinson and Shiffrin. The multi-store model has been criticized for being too simplistic. For instance, long-term memory is believed to be actually made up of multiple subcomponents, such as episodic and procedural memory. It also proposes that rehearsal is the only mechanism by which information eventually reaches long-term storage, but evidence shows us capable of remembering things without rehearsal. The model also shows all the memory stores as being a single unit whereas research into this shows differently. For example, short-term memory can be broken up into different units such as visual information and acoustic information.
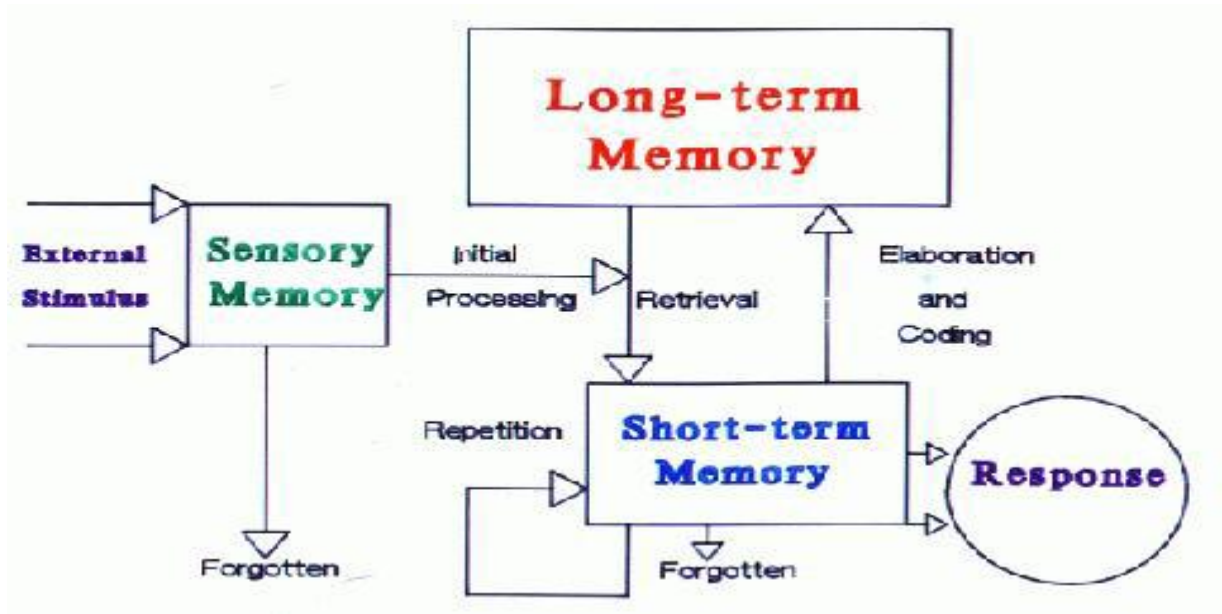
Figure (01): The multi-store model of memory (Atkinson & Shiffrin's 'multi-store' memory model, 1968**)**

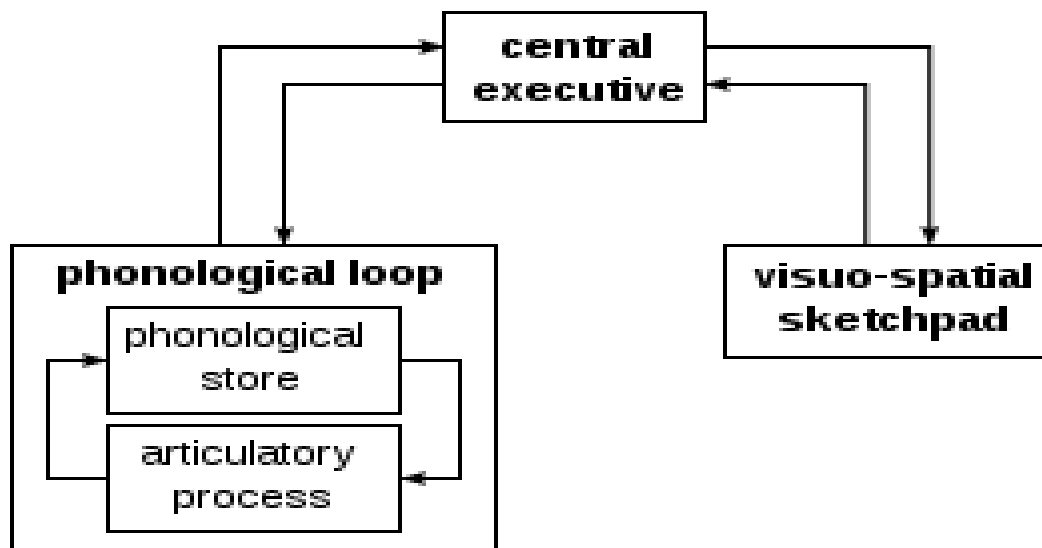## 3.2. The working memory model

Figure (02): The working memory model (Baddeley, 1974)

In this model, working memory consists of three basic stores: the central executive, the phonological loop and the visuo-spatial sketchpad. The central executive essentially acts as an attention sensory store. It channels information

to the three component processes: the phonological loop, the visuo-spatial sketchpad, and the episodic buffer. The phonological loop stores auditory information by silently rehearsing sounds or words in a continuous loop: the articulatory process (for example the repetition of a telephone number over and over again). A short list of data is easier to remember. The [visuospatial sketchpad](#) stores visual and spatial information. It is engaged when performing spatial tasks (such as judging distances) or visual ones (such as counting the windows on a house or imagining images). The episodic buffer is dedicated to linking information across domains to form integrated units of visual, spatial, and verbal information and chronological ordering (e.g., the memory of a story or a movie scene). The episodic buffer is also assumed to have links to long-term memory and semantical meaning (Baddeley, 1975).

The working memory model explains many practical observations, such as why it is easier to do two different tasks (one verbal and one visual) than two similar tasks (e.g., two visual), and the aforementioned word-length effect. However, the concept of a central executive as noted here has been criticised as inadequate and vague. Working memory is also the premise for what allows us to do everyday activities involving thought. It is the section of memory where we carry out thought processes and use them to learn and reason about topics.