心理學(榮譽)文學士
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PSY2006 Cognitive Psychology
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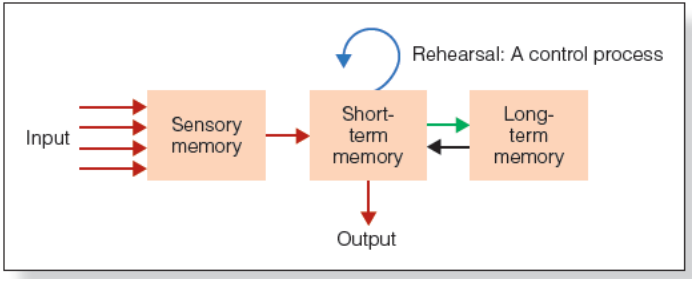
Lecture Notes **3**
Short-term and Working Memory

I. Modal Model of Memory
II. Working Memory

# I. Modal Model of Memory

## 1. Modal Model of Memory

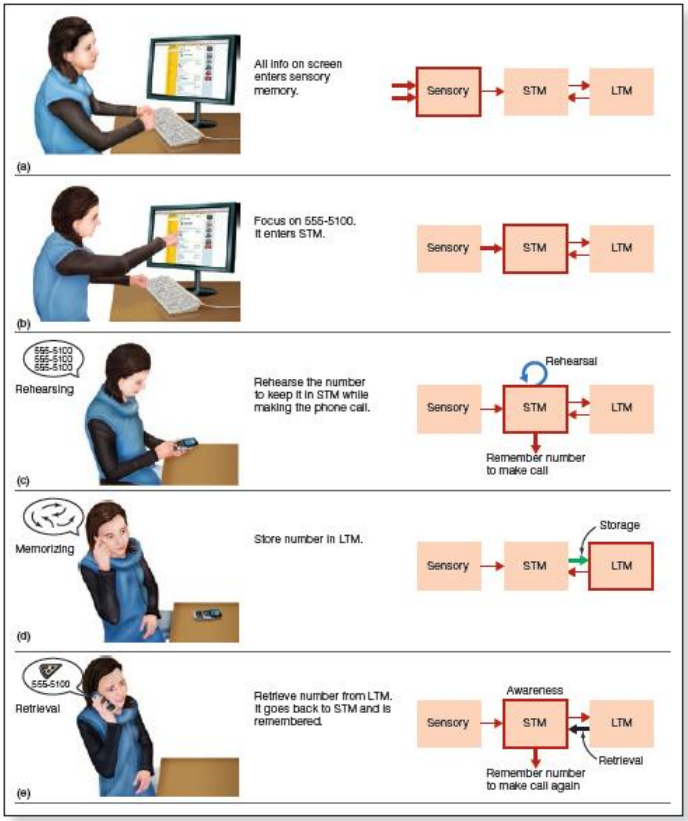
- A model proposed by Atkinson and Shiffrin describing memory as a mechanism that involves processing information through a series of stages, which include short-term memory and long-term memory. It is called the modal model because it contained features of many models that were being proposed in the 1960s.




Flow diagram for Atkinson and Shiffrin's (1968) model of memory.

- Structural Features
  - Sensory Memory – An initial stage that holds all incoming information for seconds or fractions of a second.
  - Short-Term Memory – Holds 5-7 items for about 15-30 seconds.
  - Long-Term Memory – Holds a large amount of information for years or even decades.

- Control Processes
  - Active processes that can be controlled by the person and may differ from one task to another.
  - E.g. Rehearsal – The process of repeating a stimulus over and over, usually for the purpose of remembering it, that keeps the stimulus active in short-term memory.



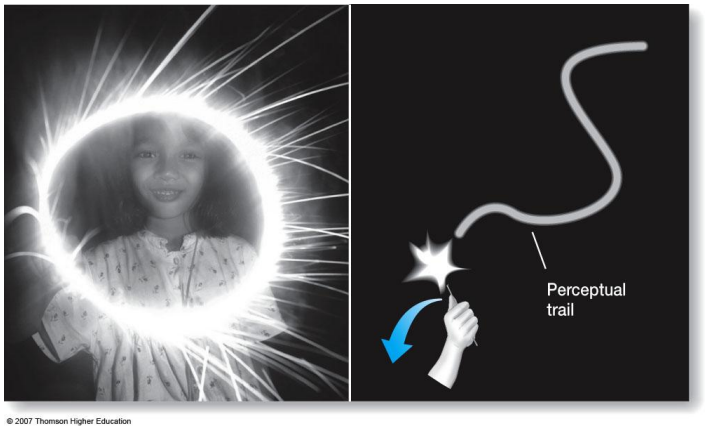

What happens in different parts of Rachel's memory as she is (a and b) looking up the phone number, (c) calling the pizza shop, and (d) memorizing the number. A few days later, (e) she retrieves the number from long-term memory to order pizza again. Darkened parts of the modal model indicate which processes are activated for each action that Rachel takes.

## 2. Sensory Memory

- A brief stage of memory that holds information for seconds or fractions of a second. It is the first stage in the modal model of memory.

- The Sparkler's Trail and The Projector's Shutter
  - Persistence of Vision
    - The continued perception of light for a fraction of a second after the original light stimulus has been extinguished.

- Sparkler
  - A sparkler can cause a trail of light when it is moved rapidly because the perception of the light is briefly held in the mind.






(a) A sparkler can cause a trail of light when it is moved rapidly. (b) This trail occurs because the perception of the light is briefly held in the mind.

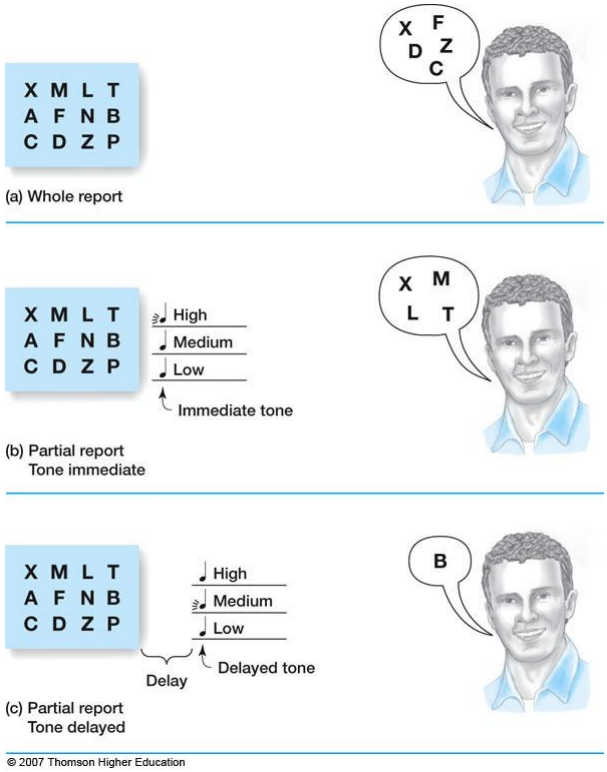
- Film
  - A person viewing a film doesn't see the dark intervals between the images because the persistence of vision fills in the darkness by retaining the image of the previous frame.

**Table 5.1** Persistence of Vision in Film

| What Happens? | What Is on the Screen? | What Do You Perceive? |
|---|---|---|
| Film frame 1 is projected. | Picture 1 | Picture 1 |
| Shutter closes and film moves to the next frame. | Darkness | Picture 1 (persistence of vision) |
| Shutter opens and film frame 2 is projected. | Picture 2 | Picture 2* |

* Note that the images appear so rapidly (24 per second) that you don't see individual images, but see a moving image created by the rapid sequence of images. This illusion of movement is called *apparent movement*.

- Sperling's Experiment: Measuring the Capacity and Duration of the Sensory Store

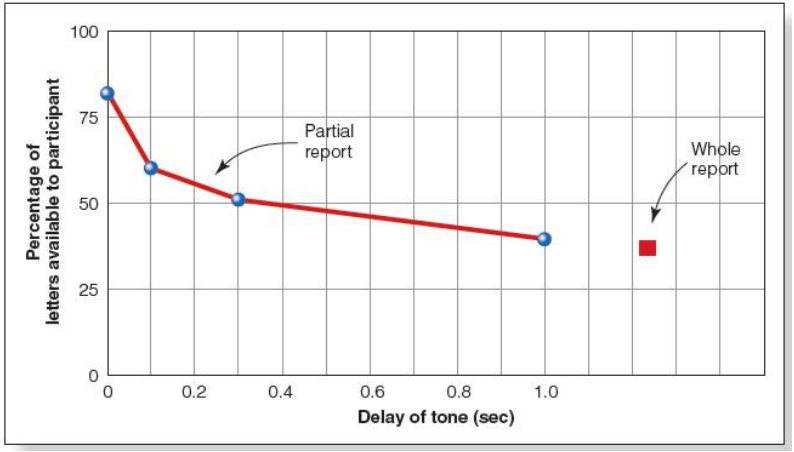



Procedure for three of Sperling's (1960) experiments. (a) Whole report method: Person saw all 12 letters at once for 50 ms and reported as many as he or she could remember. (b) Partial report: Person saw all 12 letters, as before, but immediately after they were turned off, a tone indicated which row the person was to report. (c) Delayed partial report: Same as (b), but with a short delay between extinguishing the letters and presentation of the tone.

- Whole Report Procedure – Participants were instructed to report all of the stimuli in a briefly presented display.

- Partial Report Procedure – Participants were instructed to report only some of the stimuli in a briefly presented display. A cue tone immediately after the display was extinguished indicated which part of the display to report.

- Delayed Partial Report Procedure – Participants were instructed to report only some of the stimuli in a briefly presented display. A cue tone that was delayed for a fraction of a second after the display was extinguished indicated which part of the display to report.




Results of Sperling's (1960) partial report experiments. The decrease in performance is due to the rapid decay of iconic memory (sensory memory in the modal model).

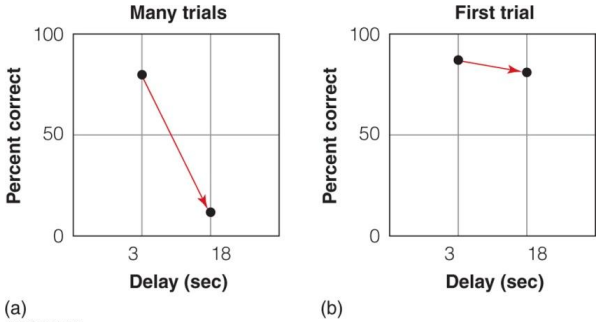
- Sensory memory can register huge amounts of information (perhaps all of the information that reaches the receptors), but it retains this information for only seconds or fractions of a second.

- Iconic Memory
  - Brief sensory memory for visual stimuli that lasts for a fraction of a second after a stimulus is extinguished.

- Echoic Memory
  - Brief sensory memory for auditory stimuli that lasts for a few seconds after a stimulus is extinguished.

## 3. Short-Term Memory

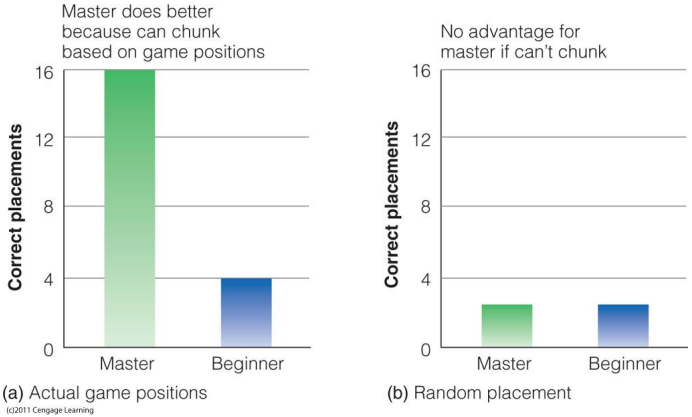
- What Is the Duration of Short-Term Memory?
  - The effective duration of STM, when rehearsal is prevented, is about 15-20 seconds or less.
    - Decay – Process by which information is lost from memory due to the passage of time.
    - Proactive Interference – When information learned previously interferes with learning new information.




Results of Peterson and Peterson's (1959) duration of STM experiment. (a) The result originally presented by Peterson and Peterson, showing a large drop I memory for letters for a delay of 18 seconds between presentation and test. These data are based on the average performance over many trials. (b) Analysis of Peterson and Peterson's results by Keppel and Underwood, showing little decrease in performance if only the

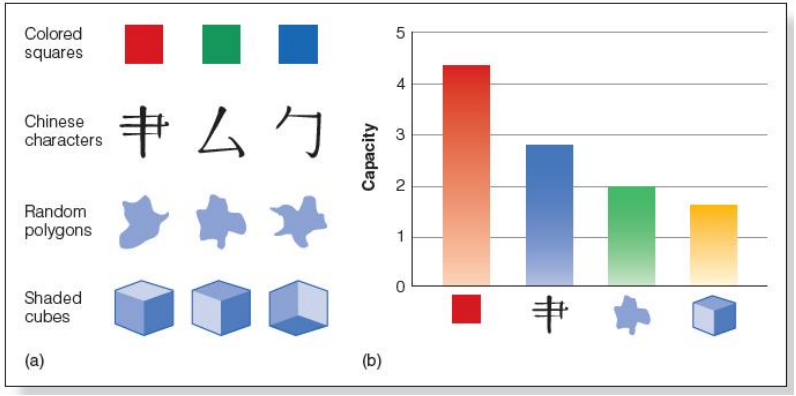
  - Retroactive Interference – When more recent learning interferes with memory for something that happened in the past.

- How Many Items Can Be Held in Short-Term Memory?
  - Digit Span
    - The number of digits a person can remember.
    - Is used as a measure of the capacity of short-term memory.
    - The capacity of STM is 5-9 items according to measurements of digit span or about 4 items according to experiments using a procedure called change detection.
  - Change Detection
    - Detecting differences between pictures or displays that are presented one after another.
    - The capacity of STM is about 4 items according to experiments using the change detection procedure.
  - Chunking
    - Combining small units into larger meaning units.
    - Can be used to increase the capacity of memory.
    - Chunk – A collection of elements that are strongly associated with each other, but are weakly associated with elements in other chunks.




Results of Chase and Simon's (1973a, 1973b) chess memory experiment. (a) The chess master is better at reproducing actual game positions. (b) Master's performance drops to level of a beginner when pieces are arranged randomly.

- How Much Information Can Be Held in Short-Term Memory?
  - Some researchers have suggested that rather than describing memory capacity in terms of "number of items", it should be described in terms of "amount of information".
  - The greater the amount of information in an image, the fewer items can be held in visual STM.
  - There is an agreement that whether considering items or information, the upper limit for STM capacity is about 4 items.




(a) Some of the stimuli used in Alvarez and Cavanagh's (2004) change detection experiment. The stimuli range from low information (colored squares) to high information (cubes). In the actual experiments, there were six different objects in each set. (b) Results showing the average number of objects that could be remembered for each type of stimulus.

## II. Working Memory

### 1. Working Memory

- A limited-capacity system for temporary storage and manipulation of information for complex tasks such comprehension, learning, and reasoning.

- Differs from STM in two ways:
  - STM is concerned mainly with storing information for a brief period of time, whereas WM is concerned with the manipulation of information that occurs during complex cognition.
  - STM is a single component, whereas WM consists of a number of components.

- Consists of four components:
  - Phonological Loop
  - Visuospatial Sketch Pad
  - Central Executive
  - Episodic Buffer

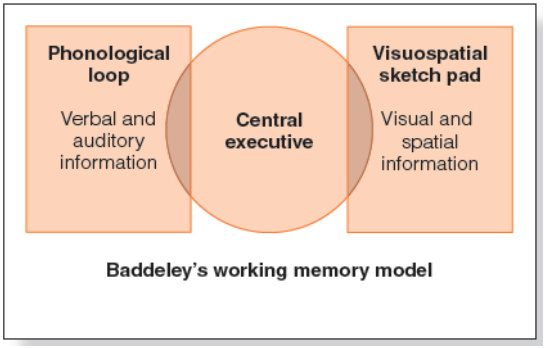



Diagram of the three main components of Baddeley and Hitch's (1974; Baddeley, 2000a, 2000b) model of working memory: the phonological loop, the visuospatial sketch pad, and the central executive.

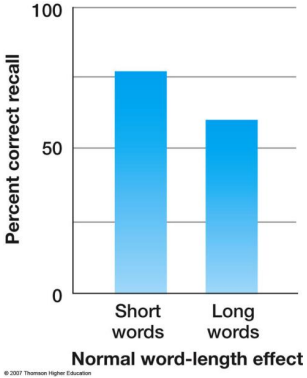
## 2. Phonological Loop

- The part of working memory that holds and processes verbal and auditory information.

- Consists of two components:
  - Phonological Store – holds a limited amount of verbal and auditory information for a few seconds.
  - Articulatory Rehearsal Process – keeps items in the phonological store from decaying.

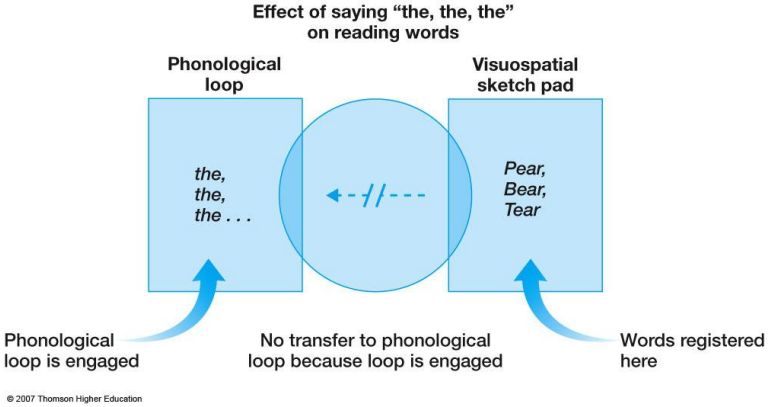
- Phonological Similarity Effect
  - An effect that occurs when letters or words that sound similar are confused. For example, T and P are examples of two similar-sounding letters that could be confused.

- Word-Length Effect
  - The notion that it is more difficult to remember a list of long words than a list of short words.

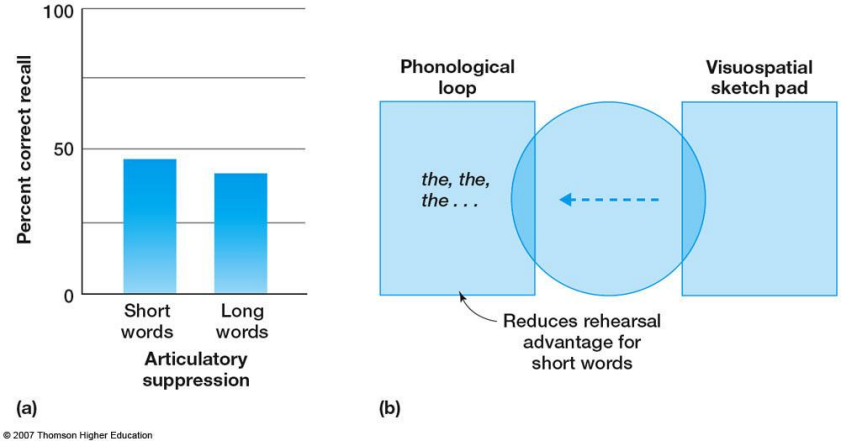



How word length affects memory, showing that recall is better for short words.

- Articulatory Suppression – Interference with operation of the phonological loop that occurs when a person repeats an irrelevant word such as "the" while carrying out a task that requires the phonological loop.




Effect of saying "the, the, the..." on reading words. The phonological similarity effect does not occur for visually presented words because the phonological loop is engaged with processing "the, the, the...". This prevents visual stimuli from being recoded verbally in the phonological loop.






(a) Saying "the, the, the..." abolishes the word-length effect, so there is little difference in performance for short words and long words (Baddeley et al., 1984). (b) Saying "the, the, the..." causes this effect by reducing rehearsal in the phonological loop.