Chapter 6: Memory

Courtesy Dr. Julie Gralow

LEARNING OBJECTIVES: Part 1

- LO 1 Define memory.
- LO 2 Identify the processes of encoding, storage, and retrieval in memory.
- LO 3 Explain the stages of memory described by the information-processing model.
- LO 4 Describe sensory memory.
- LO 5 Summarize short-term memory.
- LO 6 Give examples of how we can use chunking to improve our memory span.
- LO 7 Explain working memory and how it compares with short-term memory.
- LO 8 Define long-term memory.
- LO 9 Illustrate how encoding specificity relates to retrieval cues.
- LO 10 Identify some of the reasons why we forget.

LEARNING OBJECTIVES: Part 2

- LO 11 Explain how the malleability of memory influences the recall of events.
- LO 12 Define rich false memory.
- LO 13 Compare and contrast anterograde and retrograde amnesia.
- LO 14 Identify the brain structures involved in memory.
- LO 15 Describe long-term potentiation.

Memory: The Conductor

In 1985 conductor Clive Wearing (pictured here with his wife Deborah) developed a brain infection—viral encephalitis—that nearly took his life.

Clive recovered physically, but his memory was never the same.

An Introduction to Memory: Part 1

Memory

- Refers to information the brain receives, stores, and may retrieve for for later use
- Is not completely understood but a basic agreement on general processes involved

An Introduction to Memory: Part 2

MEMORY: ENCODING, STORAGE, AND RETRIEVAL

Encoding

- Includes the process through which information enters the memory system
- Occurs when stimuli associated with events are converted to neural activity that travels to the brain
- Involves two possible paths: Memory system entry or loss of stimuli

Memory: Part 1

MEMORY: ENCODING, STORAGE, AND RETRIEVAL

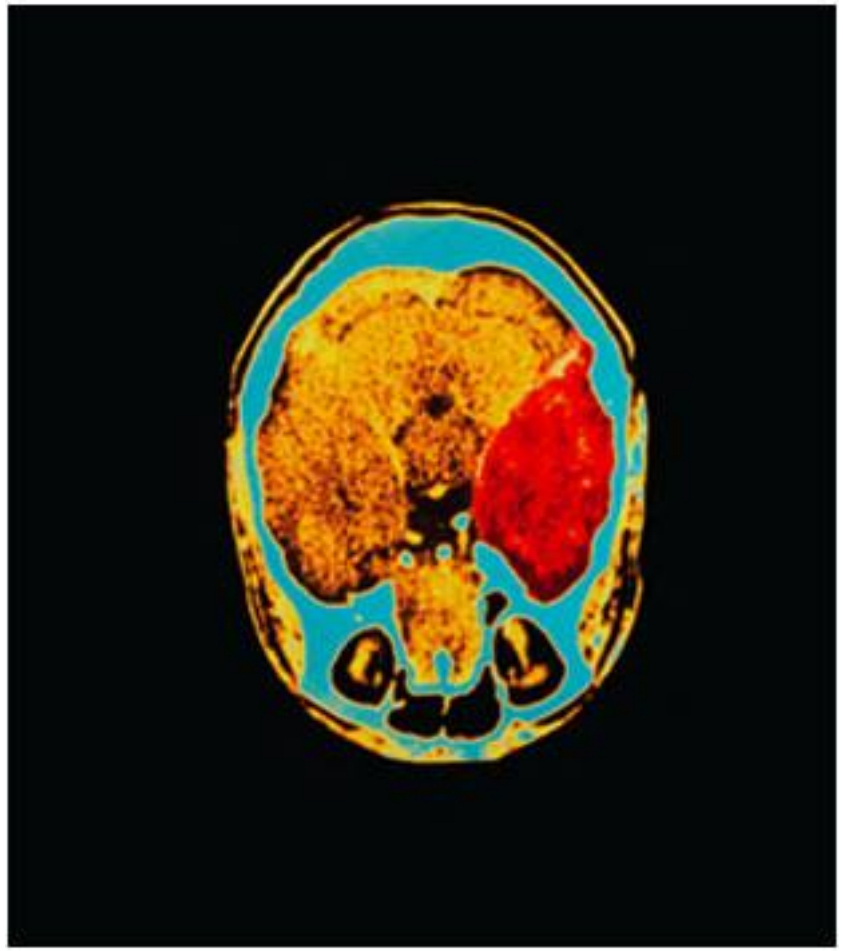
Storage

- Includes process of preserving information for possible recollection in the future

Retrieval

- Refers to the process of accessing information encoded and stored in memory

Memory: Encephalitis



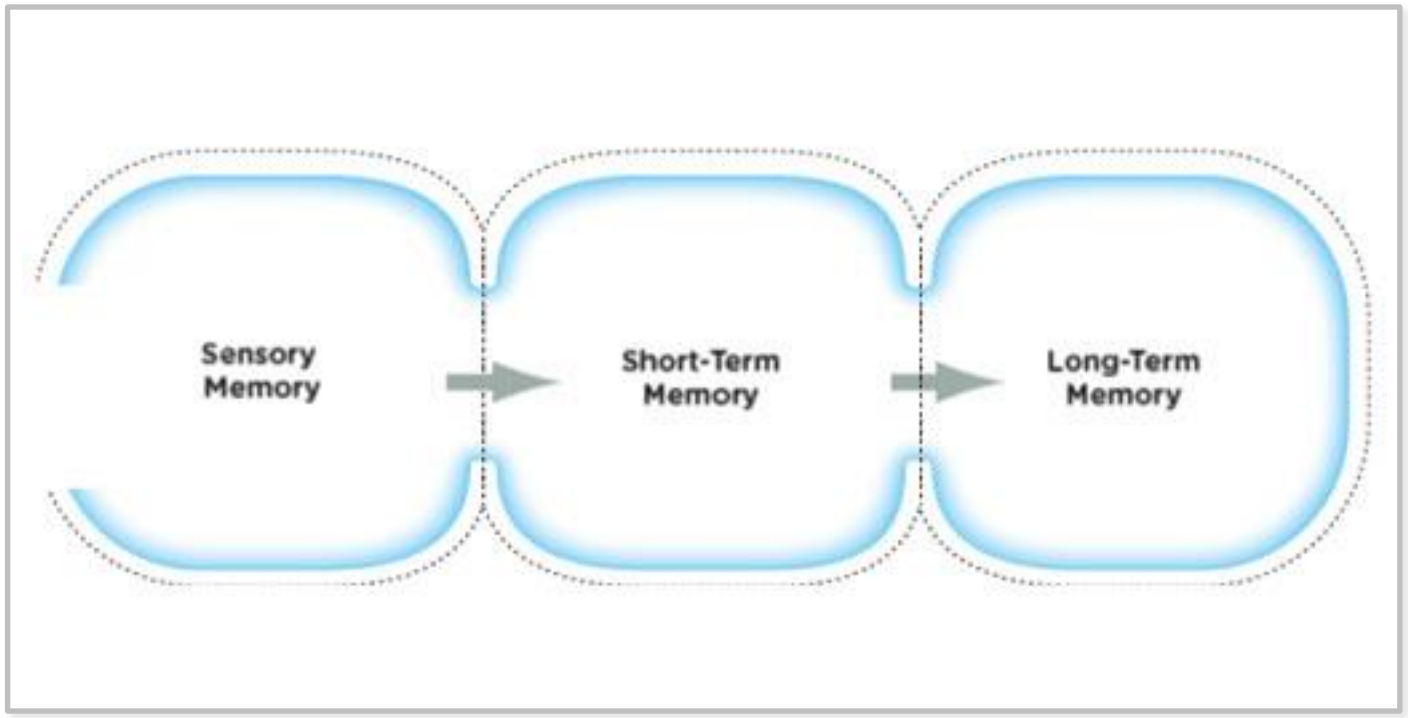
The red area in this computerized axial tomography (CAT or CT) scan reveals inflammation in the temporal lobe.

The cause of this swelling is herpes simplex virus, the same virus responsible for Clive's illness.

Memory: World Memory Athletes

- Brains of memory champions are not wired but trained to excel in memory tasks.
- Heightened activity in specific brain areas occurred **in** memory competitors' brains.
- Activity seemed to be associated with use of an imagined order after flipping through them just once.

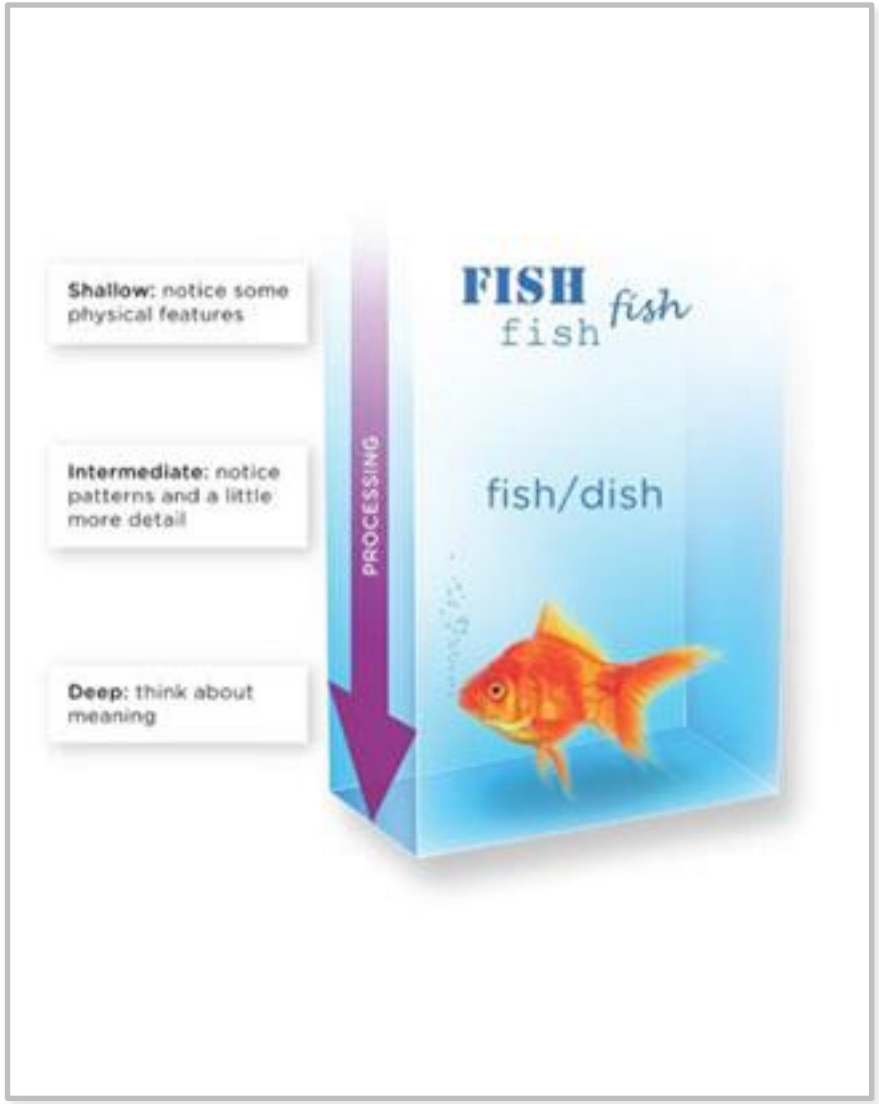
THE INFORMATION-PROCESSING MODEL OF MEMORY



One of the most influential is the information-processing model, which suggests that memory operates in a series of stages.

This model, first developed by Atkinson and Shiffrin, suggests that these stages represent a flow of information.

Memory: Levels of Processing



Memory can also be conceptualized from processing standpoint.

- Shallow
- Intermediate
- Deep

Try This: Part 1

Try to remember the name “Clive Wearing” by

(1) picturing it written out in uppercase letters (CLIVE WEARING),

(2) imagining what it sounds like (Clive Wearing rhymes with dive daring), and

(3) contemplating its underlying significance (Clive Wearing is the musician who suffers from an extreme case of memory loss).

Why Testing Boosts Learning

GETTING QUIZZED STRENGTHENS MEMORY—JOGGING KEYWORD CLUES

Why are people who are tested on materials more likely to succeed than those who simply study?

- Rawson and Pyc found that students in a practice test group were better at remembering word pairs during a final exam.
- Testing improved memory by strengthening keyword associations and weeding out cues that did not work.

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Improving Memory and Long-Term Retention of New Information

- STUDY TIPS
- Survey
- Question
- Read
- Recall
- Review
- Individualize process
- Space your study
- Minimize distraction
- Test frequently
- Sleep

Show What You Know: Part 1

1. _____ refers to the information that your brain collects, stores, and may use at a later time.

2. _____ is the process whereby information enters our memory system.

a. Retrieval

b. Encoding

c. Communication

d. Spatial memory

Show What You Know: Part 2

3. After suffering from a devastating illness, Clive Wearing essentially lost the ability to use which stage of the information-processing model?

a. long-term memory

b. sensory memory

c. memory for keywords

d. sensory register

4. How might you illustrate shallow processing versus deep processing as it relates to studying?

Flow with It: The Stages of Memory

SENSORY MEMORY: THE HERE AND NOW

Sperling

- Devised partial report method to demonstrate that more is seen than can be remembered
- Found that visual impressions in iconic memory are photograph-like in accuracy but dissolve in less than a second

How Long Does Iconic Memory Last?

Letters flash on screen, then disappear.

A tone sounds. Participants report only the row associated with that tone.

Participants can report row associated with tone, but no other row. All letters initially registered in their sensory memory, but the iconic memory dissolves before more letters can be reported.

The Stages of Memory: Sensory Memory – Part 1

Eidetic imagery

- Comes fairly close to photographic memory
- Involves young children who have the ability to "see" image or object for as long as several minutes after It has been removed from sight

Echoic imagery

- Captures very subtle changes in sound
- Lasts from about 1 to 10 seconds

Try This: Part 2

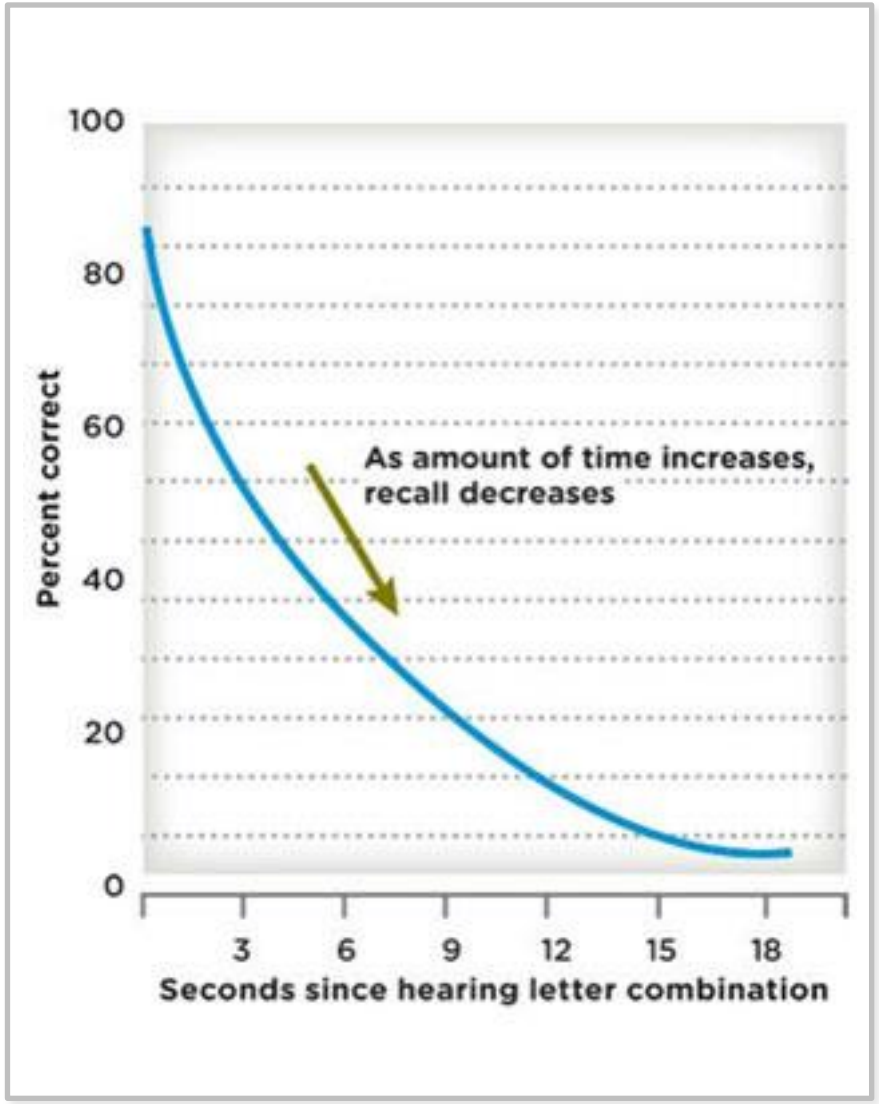
The Stages of Memory: Sensory Memory – Part 2

SHORT-TERM MEMORY

Duration

- Amount of time information is maintained and processed in STM influenced by distractions by other cognitive activities
- Limited capacity

Flow with It: The Stages of Memory – Part 1



SHORT-TERM MEMORY

Distraction can reduce the amount of time information remains in short-term memory.

When performing a distracting cognitive task, most people were unable to recall a letter combination beyond 18 seconds.

Source:

From Peterson and Peterson (1959), Figure 3, p. 195.

Think Again

MULTITASKING AND MEMORY

Bowman and colleagues

- Found students who used IMing during a reading task performed at the same level as non-IMing peers, but took longer reading time

Junco and Cotton

- Found that students who frequently text and use Facebook during study have lower GPAs than those who do not

Can you explain these results?

Flow with It: The Stages of Memory – Part 2

SHORT-TERM MEMORY

Chunking

- Grouping numbers, letters, or other items into meaningful subsets as strategy for increasing the quantity of information that can be maintained in short-term memory

The Stages of Memory: Short-Term Memory

Working memory

- Active processing of memory in short-term memory
- Maintenance and manipulation of information in the memory system

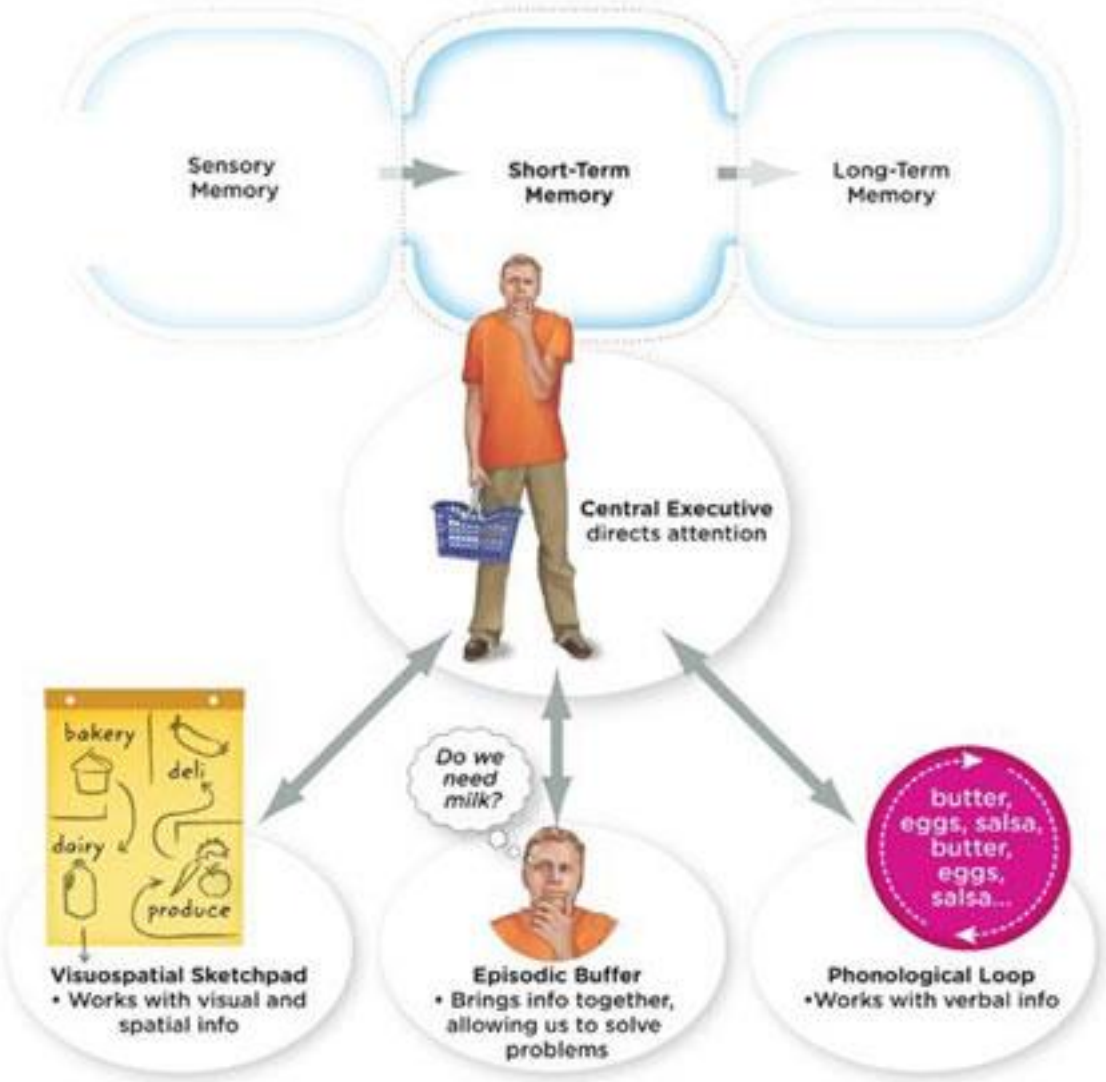
Flow with It: The Stages of Memory – Part 3

WORKING MEMORY: WHERE THE ACTION IS

Phonological loop is responsible for working with verbal information for brief periods of time.

Can you provide an example of a phonological loop?

Model of Working Memory



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Flow with It: The Stages of Memory – Part 4

WORKING MEMORY: WHERE THE ACTION IS

Visuospatial sketchpad:

- Is where visual and spatial data are briefly stored and manipulated

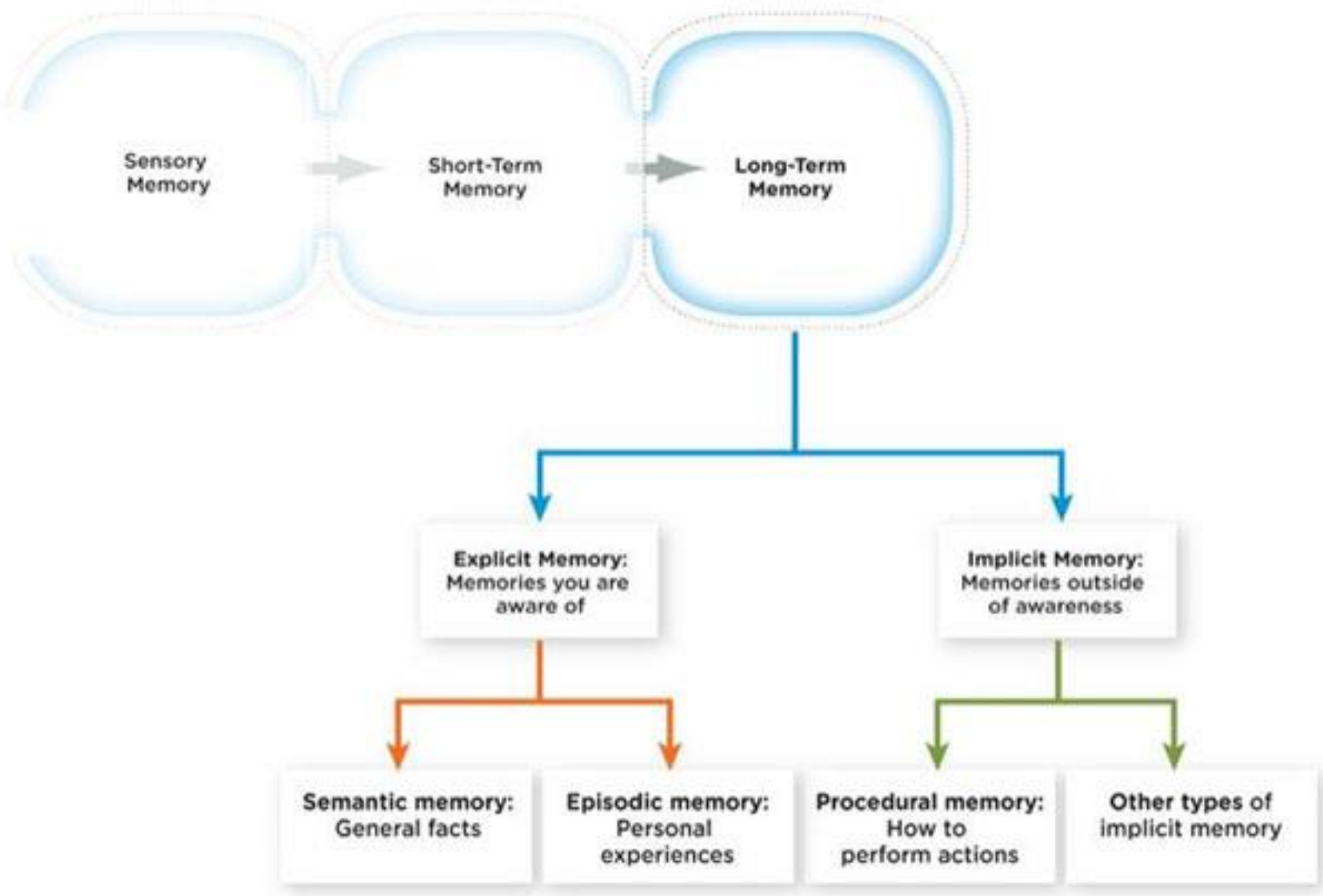
Central executive:

- Directs attention, makes plans, and coordinates activities
- Determines what information is used and what is ignored

Episodic buffer:

- Forms the bridge between memory and conscious awareness

Long-term Memory



The Stages of Memory: Long-Term Memory – Part 1

Explicit memory

- Type of memory you are aware of having and can consciously express in words or declare, including memories of facts and experiences.

Semantic memory

- Memory of information theoretically available to anyone, which pertains to general facts about the world; a type of explicit memory.

The Stages of Memory: Long-Term Memory – Part 2

Episodic memory

- Record of memorable experiences or “episodes” including when and where an experience occurred; a type of explicit memory.

Flashbulb memory

- Detailed account of circumstances surrounding emotionally significant or shocking, sometimes historic, event.

Implicit Memory

IMPLICIT MEMORY

- Memory of something one knows or knows how to do
- May be automatic or unconscious

PROCEDURAL MEMORY

- Unconscious memory of how to carry out variety of skills and activities; type of implicit memory

Try This: Part 3

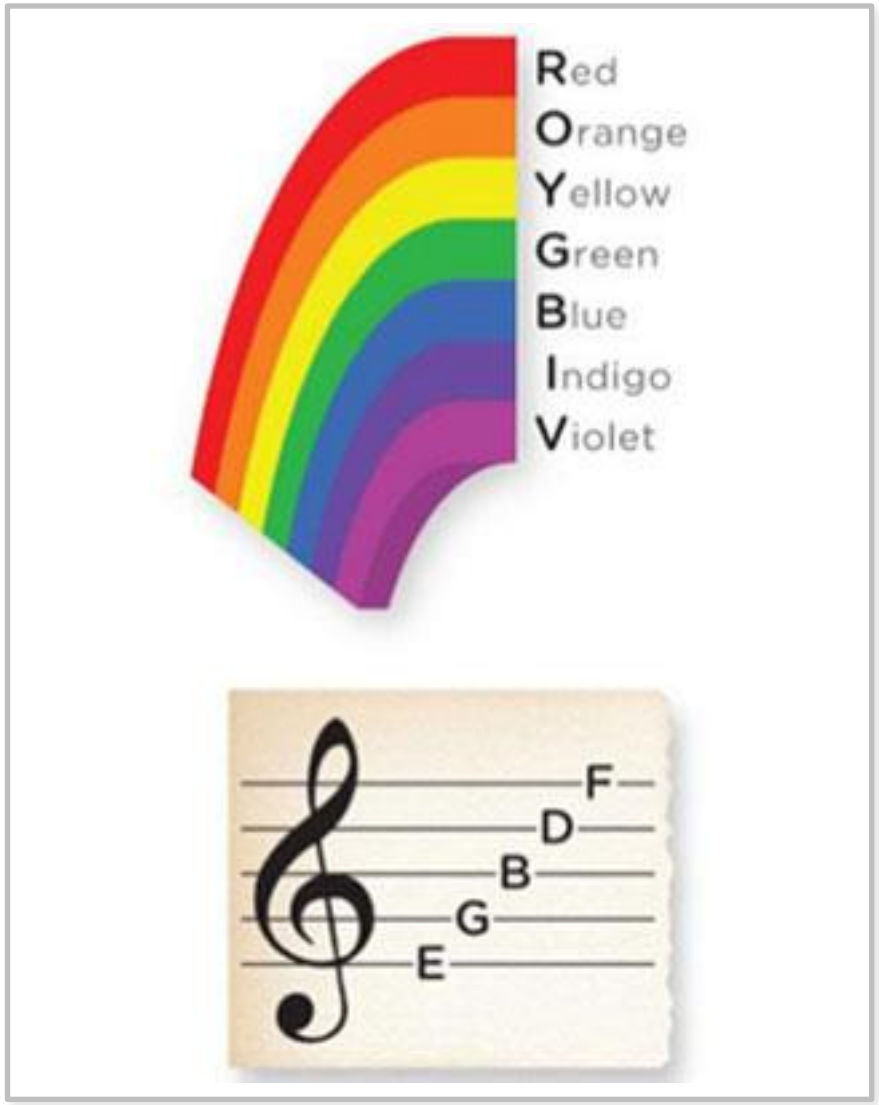
Take 15 seconds and try to memorize these seven words in the order they appear.

puppy stop sing sadness soccer kick panic

Now close your eyes and see how many you recall.

How did you do?

Memory Aids



Mnemonics

- Mnemonics help us translate information into a form that is easier to remember.

Method of loci

- Mnemonic device in which person visualizes items to be learned with landmarks in some familiar place

Flow with It: The Stages of Memory – Part 5

MEMORY AIDS: PUT YOUR MEMORY TO THE TEST

Bower and colleagues

- Found that participants were better able to learn a word list if the information was organized in any meaningful way
- Reported word learning was three times more effective when a hierarchy was used

Flow with It: The Stages of Memory – Part 6

PROCESSING, EFFORT, AND IMPROVING LONG-TERM MEMORY

Automatic and effortful processing

- Requires work; intentional

Maintenance rehearsal

- Involves repeated rehearsal of information to be learned; increases length of time information held in short-term memory

Elaborative rehearsal

- Connects information to knowledge in long-term memory; deep level of encoding

Flow with It: The Stages of Memory – Part 7

PROCESSING, EFFORT, AND IMPROVING LONG-TERM MEMORY

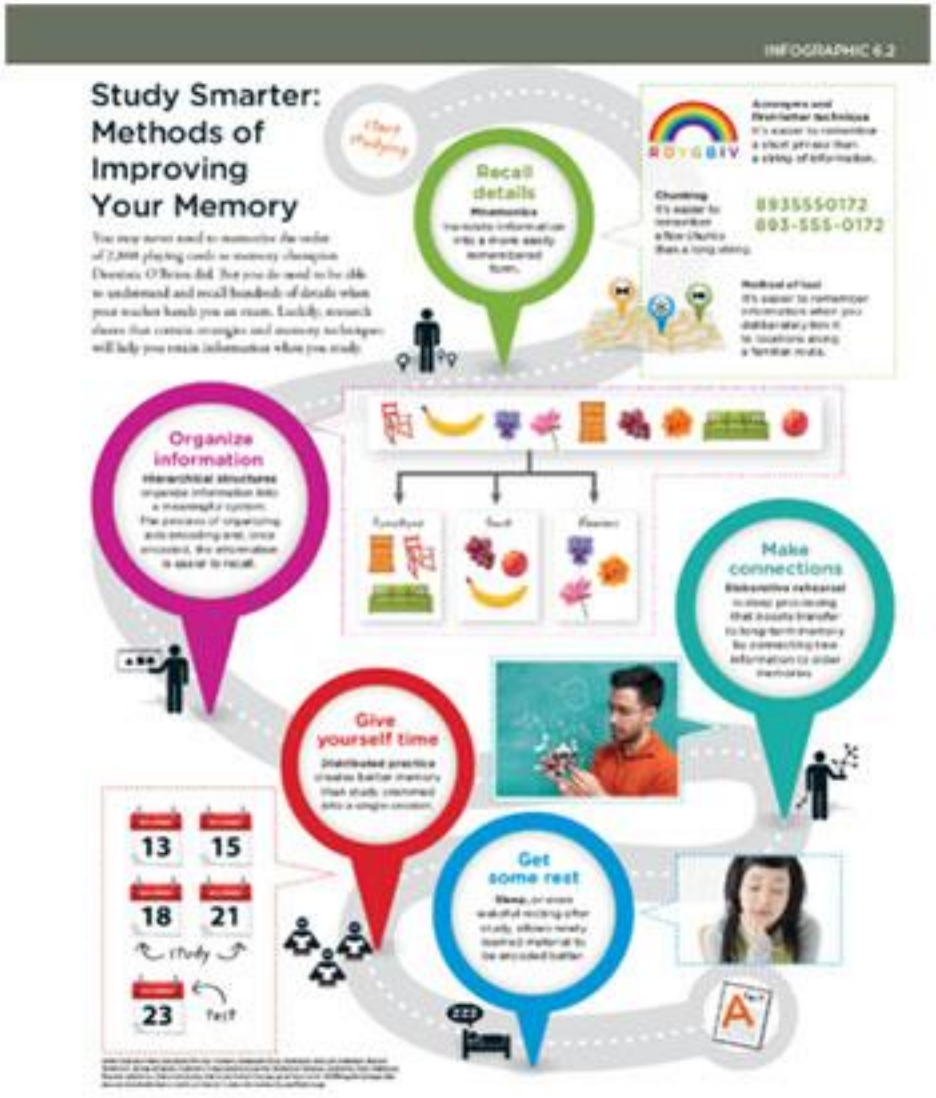
Massed practice

- Cramming

Distributed practice

- Separating study or practice sessions
- Influenced by culture and beliefs

Study Smarter: Methods of Improving Your Memory



Across the World

MEMORY AND CULTURE

Cultural differences

- Chinese people are more likely than Americans to remember social and historical occurrences and focus memories on other people; collectivist
- Americans tend to recall events as they relate to individual actions and emotions; individualistic

Flow with It: The Stages of Memory – Part 8

PROCESSING, EFFORT, AND IMPROVING LONG-TERM MEMORY

Sleep and memory

- Adequate sleep aids in memory processing

Show What You Know: Part 3

1. Your best friend tells you to close your eyes because she has a present for you. Just after you close your eyes, you momentarily “see” an image of her face. This is an example of:

a. echoic memory.

b. iconic memory.

c. spatial memory.

d. semantic memory.

Show What You Know: Part 4

2. According to the information-processing model, our short-term memory can hold onto information for up to about _____ if we are not distracted by something else.

a. 10 seconds

b. 30 seconds

c. 45 seconds

d. 60 seconds

Show What You Know: Part 5

3. As you enter the airport, you try to remember the location of the baggage claim area. You remember the last time you picked up your friend at this airport, and using your visuospatial sketchpad, realize the area is to your left. This ability demonstrates the use of your:

a. sensory memory.

b. working memory.

c. phonological loop.

d. flashbulb memory.

4. _____ memory is the type of memory you are aware of having and can consciously declare, whereas _____ memory is a memory of something you know how to do, but which might be automatic or unconscious.

Show What You Know: Part 6

5. On 9/11 Tanya was watching television when a news bulletin announced the terrorist attacks. She has vivid memories of that moment, including what she was doing, the friends she was with, and many details of her surroundings. This type of memory is known as a(n):

a. phonological loop.

b. sensory memory.

c. implicit memory.

d. flashbulb memory.

6. Develop a mnemonic device to help you memorize the following terms from this section: explicit memory, semantic memory, episodic memory, flashbulb memory, implicit memory, and procedural memory.

Retrieval and Forgetting: Part 1

WHAT CAN YOU RETRIEVE?

Retrieval cues

- Stimuli that aid in retrieval of information that is difficult to access

Priming

- Stimulation of memories as result of retrieval cues in environment

Retrieval and Forgetting: Part 2

"One Hour Numbers" is one of the most demanding events in the World Memory Championships.

Contestants are given 1 hour to memorize as many numbers as possible, and then 2 hours to write them in order on paper.

The world record, currently held by Wang Feng of China, is 2660 digits (World Memory Statistics, 2013).

Retrieval and Forgetting: Part 3

WHAT CAN YOU RETRIEVE?

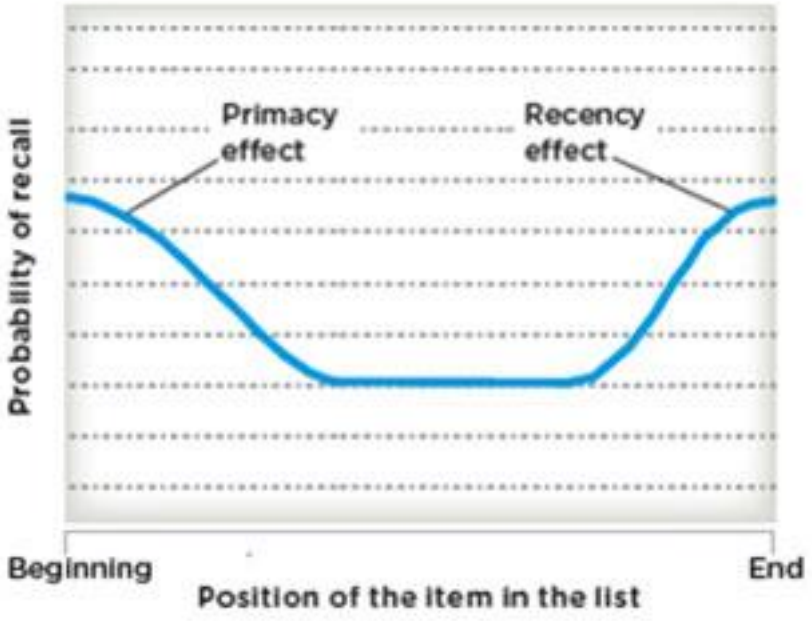
Recall

- Retrieving information held in long-term memory without explicit retrieval cues; more difficult than recognition

Recognition

- Matching incoming data to information stored in long-term memory; just have to identify information rather than come up with information

Retrieval and Forgetting: Part 4

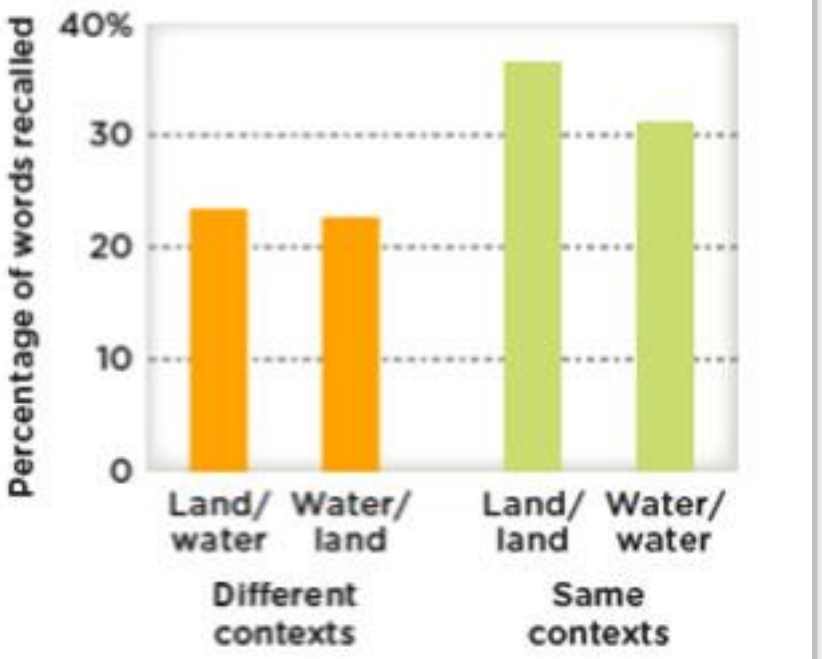


SERIAL POSITION EFFECT

Items at the beginning and the end of a list are more likely to be recalled.

- Primacy effect
- Recency effect

Retrieval and Forgetting: Part 5



DOES CONTEXT INFLUENCE MEMORY RETRIEVAL?

Encoding specificity principle

Godden and Baddeley asked participants to learn a list of words in two contexts: underwater and on dry land.

The participants had an easier time recalling words when learning and recalling happened in the same setting (learning underwater and recalling underwater, or learning on dry land and recalling on dry land).

Source: Godden and Baddeley, 1975

Context-dependent memories are easier to access when the encoding and retrieval occur in similar contexts.

Retrieval and Forgetting: Part 6

Mood and memory

- The deeper the processing, the greater the likelihood of retrieval.
- The origin of a memory provides a host of retrieval cues.

Mood congruence

- Memory is facilitated when physiological and psychological conditions are similar at time of encoding and retrieval.
- Retrieval also easier if content of memory corresponds to present emotional state

Cues . . . Retrieval Cues

While watching your favorite James Bond movie, you pick up on all sorts of background stimuli from the environment.

Retrieval and Forgetting: Part 7

HOW EASILY WE REMEMBER: MEMORY SAVINGS

Ebbinghaus

- First to quantify effect of relearning
- Noted the reduced time taken in relearning

Bowers

- People who have knowledge of language (non-explicit) from early life often show a “memory savings” when trying to relearn language as adults.

Retrieval and Forgetting: Part 8

HOW EASILY WE FORGET: MEMORY SLIPS EXPLAINED

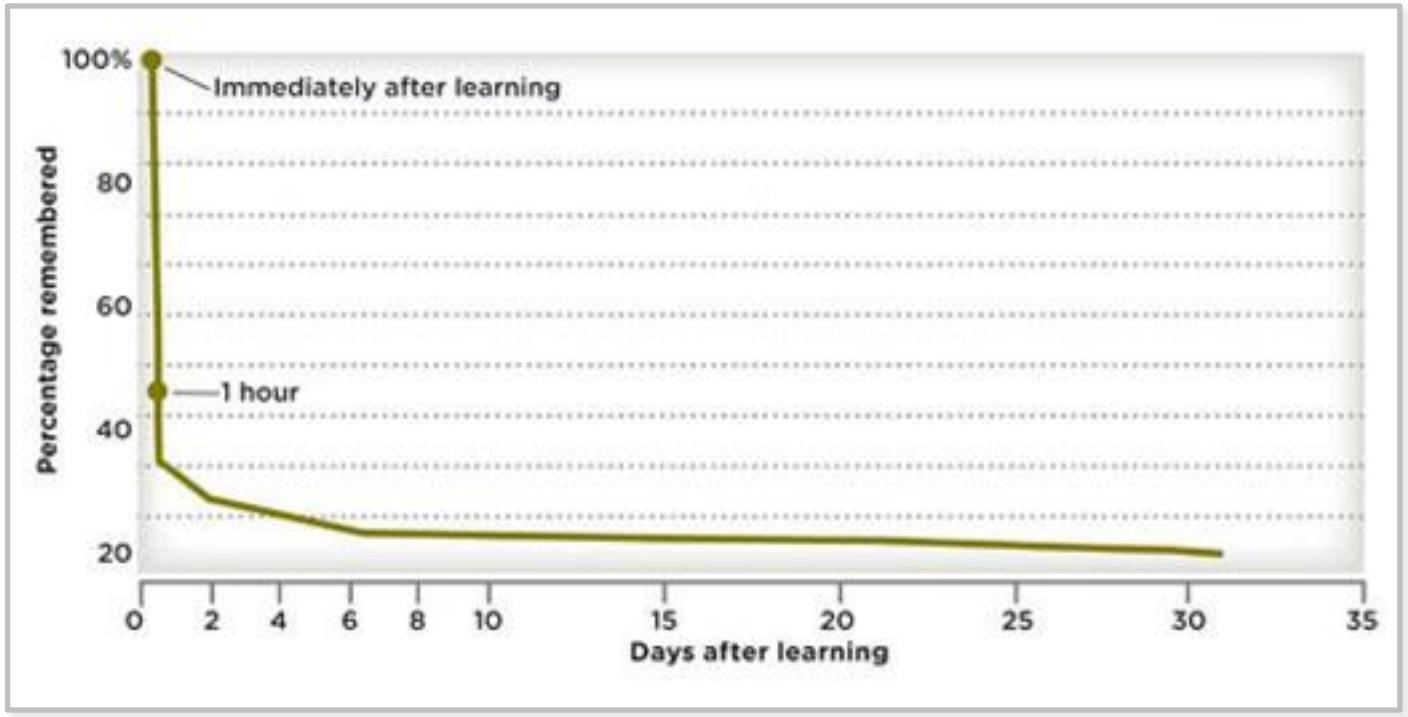
Ebbinghaus

- First to demonstrate how rapidly memories vanish

Encoding failures

- Cause of forgetting dependent on stage of memory processing at instance of memory failure

Ebbinghaus's Curve of Forgetting



Ebbinghaus discovered that most forgetting occurs within 1 hour of earning and then levels off.

Try This: Part 4

Look at the 10 pennies above. Which one is correct?

Retrieval and Forgetting: Part 9

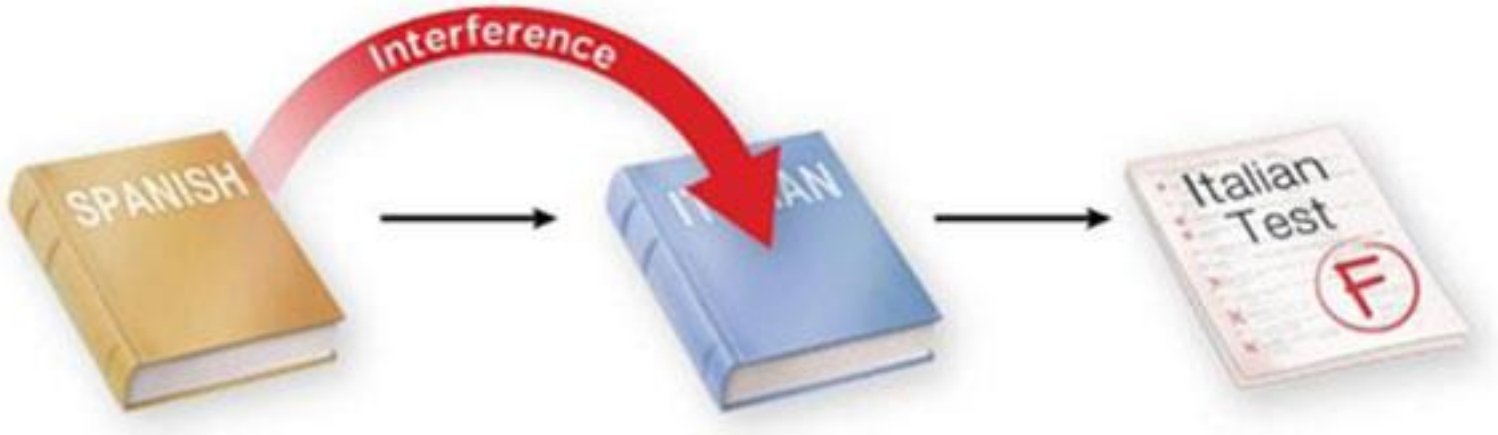
HOW EASILY WE FORGET

Memory slips explained

- Storage failure and memory decay
- Tip-of-the-tongue phenomenon (retrieval failure)
- Hyperthymestic syndrome (remembering everything)

Proactive and Retroactive Interference

Proactive Interference:
Old information interferes with newly learned information



Time

Retroactive Interference:
New information interferes with information learned in the past

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Show What You Know: Part 7

1. _____ suggests that retrieving memories is easier in the context in which they were made.

a. The encoding specificity principle

b. Retroactive interference

c. Proactive interference

d. The curve of forgetting

Show What You Know: Part 8

2. Your friend remarks that her scores are better when she studies and takes her quiz in Starbucks than if she studies in Starbucks but takes the quiz at home. She is exhibiting:

a. context-dependent memory.

b. proactive interference.

c. retroactive interference.

d. mood-congruency of memory.

Show What You Know: Part 9

3. Ebbinghaus reported that his memory of word lists plunged the first hour after he learned them; he displayed this in his:

a. encoding specificity principle.

b. curve of forgetting.

c. recency effect.

d. serial position effect.

4. Imagine a friend is almost finished with her application for a job she really wants.

5. Create two arguments for when she should submit her application using what you know about the serial position effect (applications are being accepted for a seven-day period): one based on the primacy effect, the other on the recency effect.

True or False?

Memories are not reliable records of reality.

The Reliability of Memory: Misinformation

Misinformation effect

- Memories can be changed in response to new information.
- Eyewitness accounts can be altered by variety of factors that follow an event to be recalled.

The Reliability of Memory

FALSE MEMORIES

Would you believe that looking at photoshopped pictures can lead to the creation of false memories?

In one study, it was discovered that participants could “remember” hot air balloon rides they never took after looking at doctored photos of themselves as children on balloon rides.

Controversies

THE DEBATE OVER REPRESSED CHILDHOOD MEMORIES

The APA and other organizations have investigated repressed memory and offered several conclusions.

- The repressed memory debate should not detract from child sexual abuse issues.
- Most sexual abuse victims have at least one memory.
- Memories of past abuses can be forgotten and remembered at a later date.
- People do create false memories of experiences.
- There is not a complete understanding of how accurate and flawed memories are formed.

Show What You Know: Part 10

1. The _____ refers to the tendency for new and misleading information to distort memories.

2. Your uncle claims he attended a school play in which you played the Cowardly Lion. He has described the costume you wore, the lines you mixed up, and even the flowers he gave you. At first you can't remember the play, but eventually you seem to. Your mother insists you were never in that school play, and your uncle wasn't in the country that year, so he couldn't have attended the performance at all. Instead, you have experienced a:

a. curve of forgetting.

b. state-dependent memory.

c. savings score.

d. rich false memory.

Show What You Know: Part 11

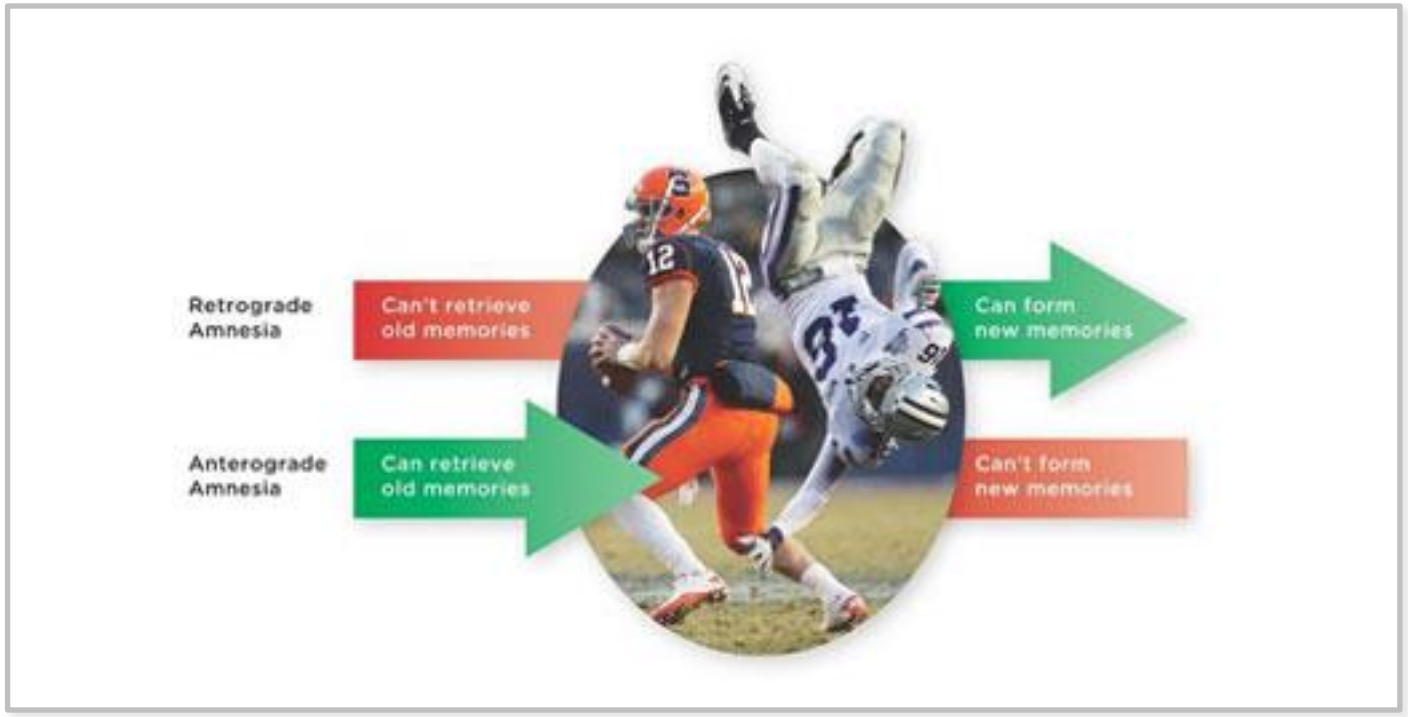
3. Loftus and Palmer (1974) conducted an experiment in which the wording of a question (using “smash” versus “hit”) significantly influenced participants’ recall of the event. What does this suggest about the malleability, or changeability, of memory?

The Biology of Memory: Part 1

Exploring the causes of memory failure in cases of amnesia can aid in the understanding of the biological basis of memory.

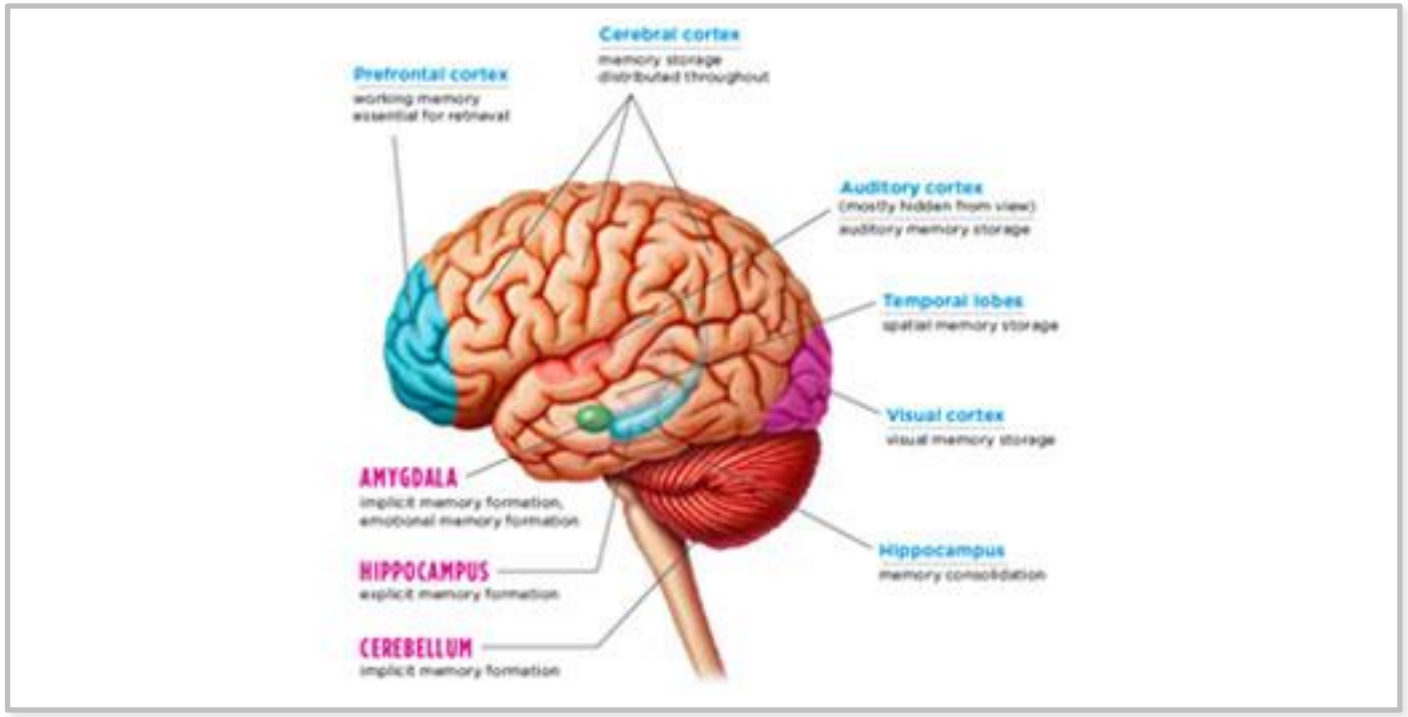
- Amnesia can result from either physical or psychological conditions.
- Two different types and degrees of amnesia
  - Anterograde
  - Retrograde

RETROGRADE AND ANTEROGRADE AMNESIA



Retro means “before,” so retrograde amnesia is the inability retrieve memories for events that occurred before an amnesia-causing injury. Antero means “after,” so anterograde amnesia is inability to form memories for events that occur after an injury.

Memory: Part 2



Memory is a complex system involving multiple structures and regions of the brain.

Memory is formed, processed, and stored throughout the brain, and different types of memory have different paths.

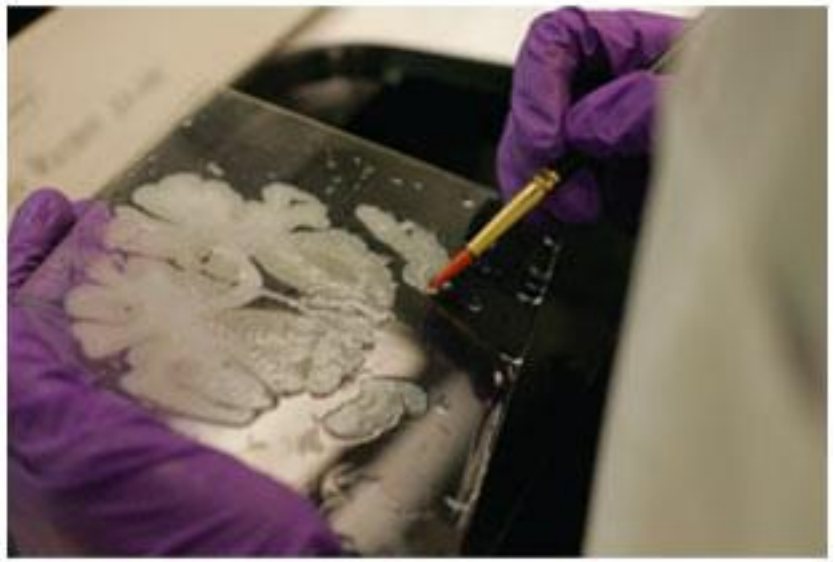
The Biology of Memory: Part 2

ROLE OF THE HIPPOCAMPUS

Research findings

- Hippocampus is essential for creating new explicit but not implicit memories.
- Explicit memories are processed and stored in other parts of the brain, including the temporal lobes and areas of the frontal cortex.
- Hippocampus plays central role in laying down new memories but does not serve as ultimate destination.

Forming New Memories



In an attempt to control the disabling seizures of a man named Henry Molaison (H.M.), doctors surgically removed portions of his brain, including the hippocampus.

The surgery affected H.M.'s memory.

He had profound anterograde amnesia: He could tap old memories, but he could no longer make new explicit memories.

However, he could still create implicit memories. Using information gathered about H.M.'s brain, scientists have been able to directly connect the hippocampus to the creation of new explicit memories.

After his death, H.M.'s brain was cut into over 2000 slices that were preserved and digitized for research.

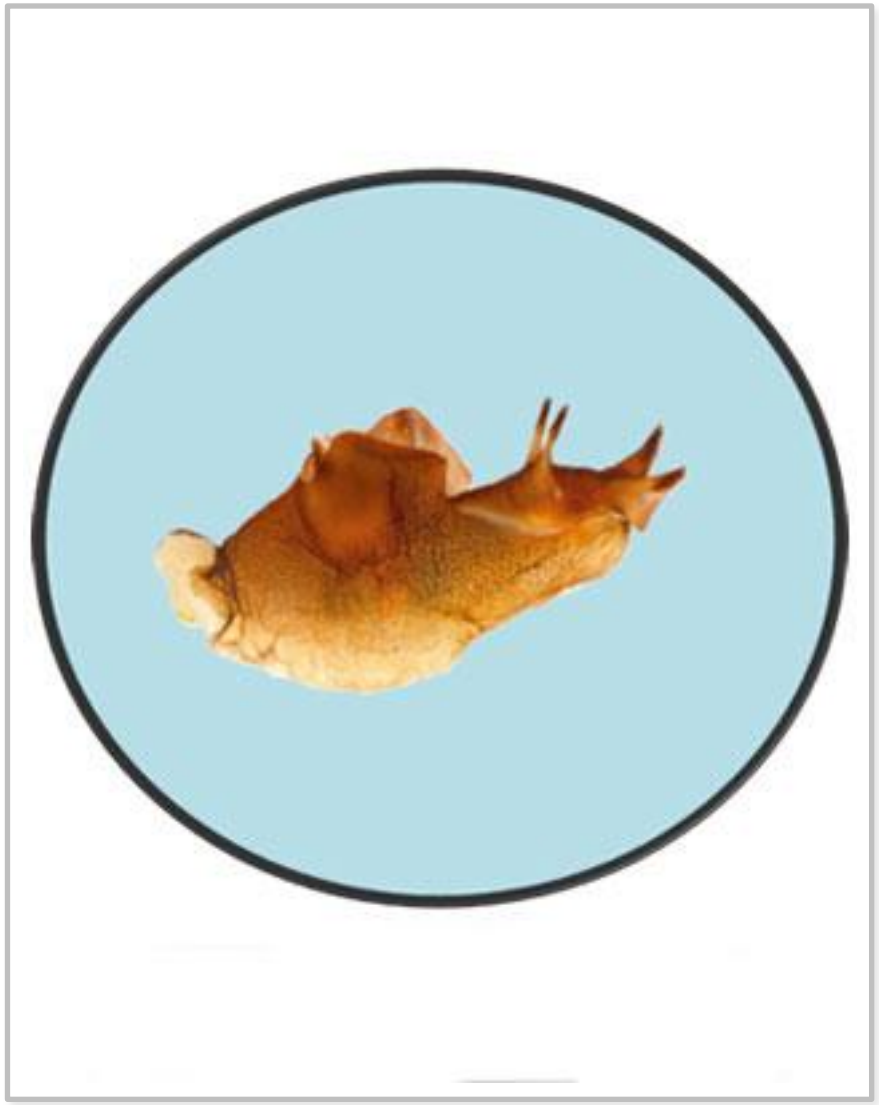
What Marijuana Reveals About Memory

GLIAL CELLS, NOT NEURONS, ARE RESPONSIBLE FOR MARIJUANA-INDUCED FORGETFULNESS

- Research in recent years has revealed that glia are implicated in many unconscious processes and diseases.
- Newer findings from stoned mice reveal that astrocytes, a type of glia, also play a principle role in working memory.

What potential might this offer to the use of marijuana as a pain-reliever?

The Biology of Memory: Part 3



SMART SLUG

Long-term potentiation involves the increased efficiency of neural communication over time, resulting in learning and the formation of memories.

Studying the neurons of sea slugs, researchers have observed the synaptic changes that underlie memory.

Studying the neurons of sea slugs, researchers have observed the synaptic changes that underlie memory.

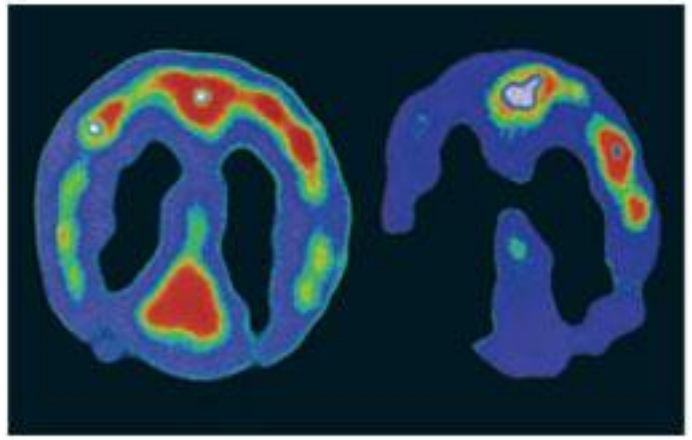
The Biology of Memory: Part 4

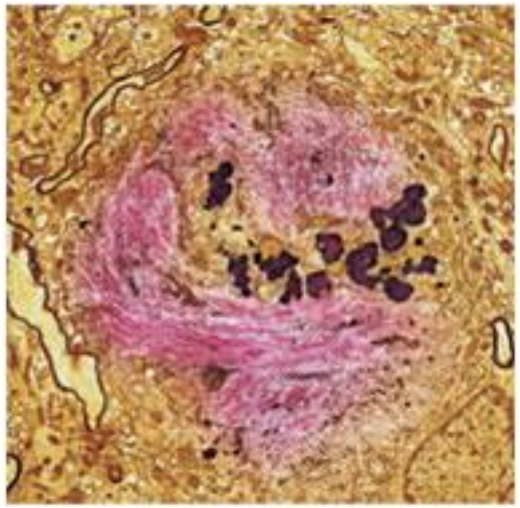
WHERE MEMORIES LIVE IN THE BRAIN—A MICRO PERSPECTIVE

Alzheimer's Disease

- Progressive, devastating brain illness that causes cognitive decline, including memory, language, and thinking problems.
  - Neurofibrillary tangles
  - Amyloid plaques

Inside Alzheimer's





PET scan (shown above, left) depicts the brain of a normal person, while the scan (above, right) shows that of a person with Alzheimer's. Studies using PET suggest a slowing of brain activity in certain regions of the Alzheimer's brain (Alzheimer's Association, 2013). The neurofibrillary angles (far right image, with tangles in pink) result from twisted protein fibers accumulating inside brain cells.

Facts about Memory Loss: Part 1

- **Memory loss does not have to be an inevitable part of aging. Occasionally forgetting where you put your keys does not mean you have a degenerative memory disorder. This table provides some facts you should know about memory loss.**
- In the United States, 1 out of every 8 people who are 65 or older suffers from Alzheimer's disease, which leads to loss of memory and other cognitive functions (Alzheimer's Association, 2010).
- The prevalence of dementia will double every 20 years, reaching 81 million by the year 2040 (Ferri et al., 2005).
- There is no definitive way to know whether you or a family member will suffer from a neurocognitive disorder: most cases result from a complex combination of genetic, environmental, and lifestyle factors.

Facts about Memory Loss: Part 2

- Studies of both animals and people have linked physical exercise to a variety of positive changes in the brain, including enhanced blood flow, increased thickness of the cortex. and less aged-related deterioration of the hippocampus (Polidori, Nelles, & Pientka, 2010).
- Some research suggests that people who begin exercising in their thirties (and stick with it) experience less cognitive decline than their sedentary peers by the time they reach their forties and fifties (Hertzog et al., 2009), although consistent exercise at any age has lasting cognitive benefits (Cotman & Berchtold, 2002; Kramer, Erickson. & Colcombe. 2006).
- Intellectually engaging activities such as reading books and newspapers, writing, drawing, and solving crossword puzzles have been associated with a lower risk of memory loss (Hertzog et al., 2009; Wang, Karp, Winblad, & Fratiglioni, 2002).
- Being socially active and hooked into social networks may reduce the risk of developing dementia (Fratiglioni, Paillard-Borg, & Winblad, 2004).

Show What You Know: Part 12

1. _____ refers to the inability to lay down new long-term memories, generally resulting from damage to the brain.

a. Anterograde amnesia

b. Retrograde amnesia

c. Infantile amnesia

d. Long-term potentiation

Show What You Know: Part 13

2. The _____ is a pair of seahorse-shaped structures in the brain that play a central role in memory.

a. engram

b. temporal lobe

c. hippocampus

d. aplysia

Show What You Know: Part 14

3. _____ is the process of memory formation, which moves a memory from the hippocampus to other areas of the brain.

a. Long-term potentiation

b. Memory consolidation

c. Priming

d. The memory trace

4. Infantile amnesia makes it difficult for people to remember events that occurred before the age of 3. What is your earliest memory and how old were you when that event occurred?