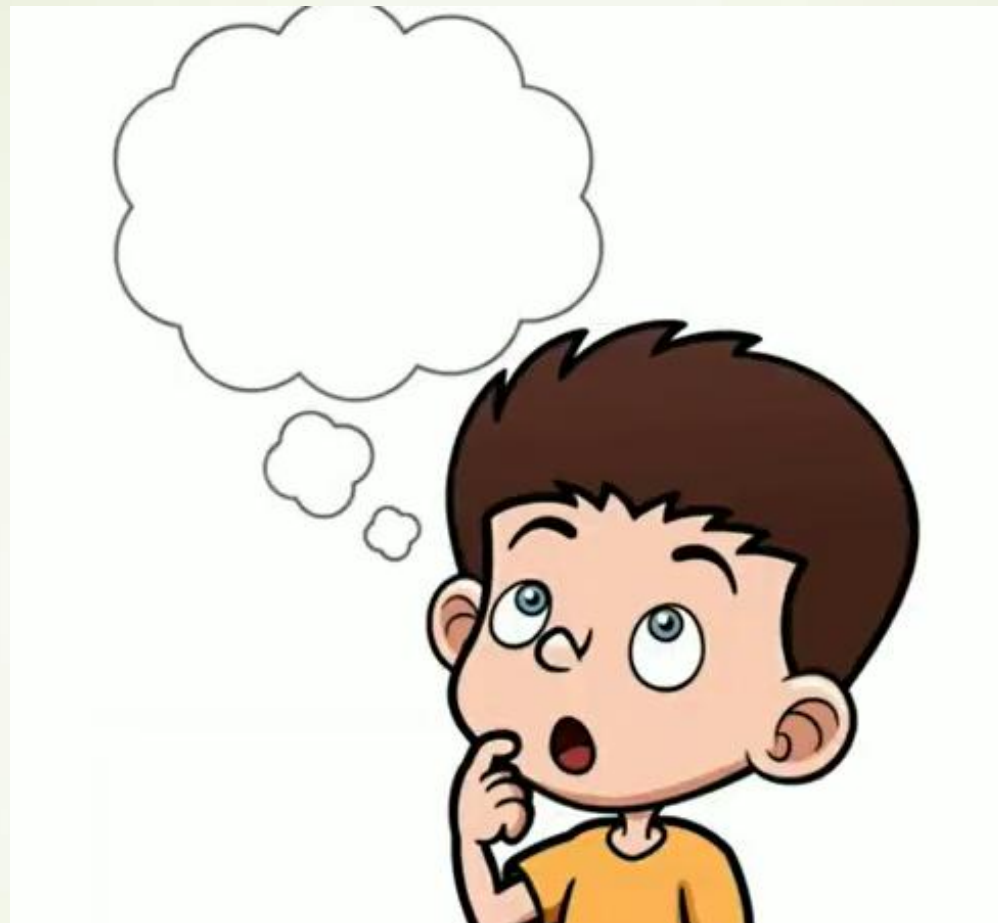


Cognitive Computing



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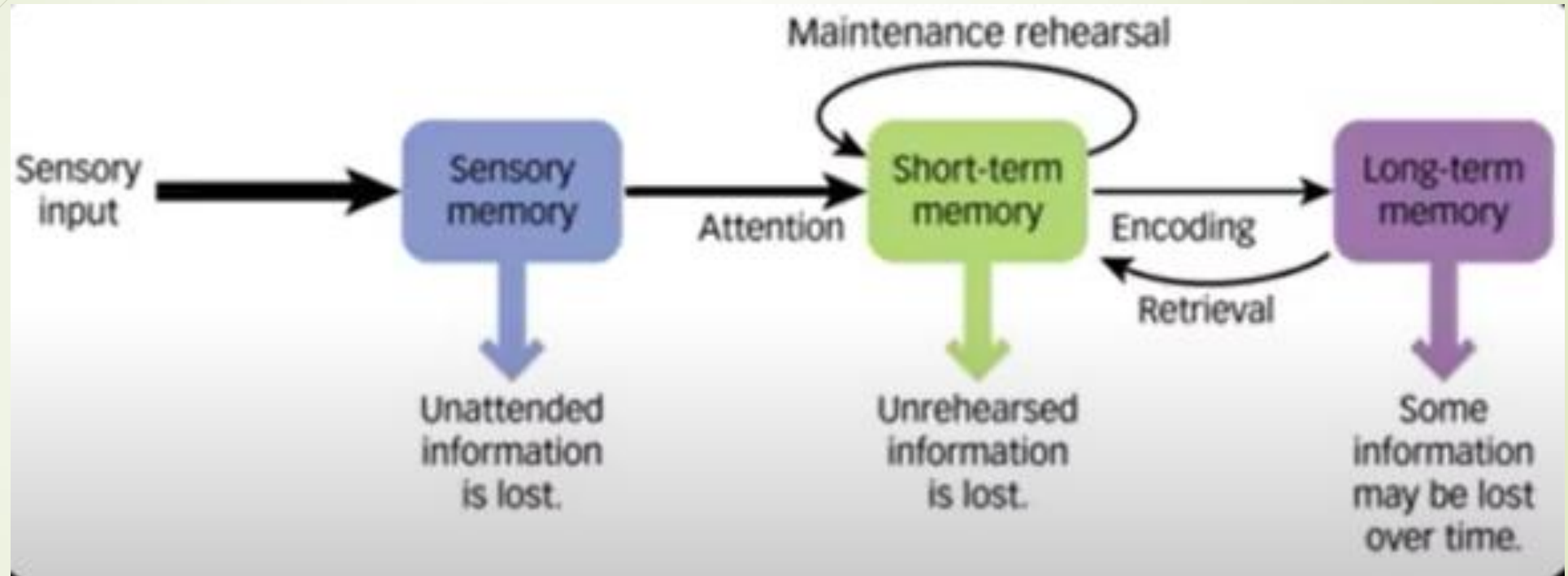
The Atkinson-Shiffrin Model (1968)

Modal Model

1. This is one of the earliest models of how humans process information
2. Information “flows” from one system to another

- Most influential model of memory
- Information Processing model

Atkinson–Shiffrin or Modal model






Sensory Memory

A. Iconic Memory

1. Visual Sensory Memory – a raw copy of the visual world
2. Extremely short duration ($>1s$)
3. Classic research by Sperling (1960)

B. Echoic Memory – auditory sensory memory



Sperling Experimentation

Whole report: subjects are presented with a matrix of alphanumeric characters for 15-500ms. When asked to report all of the characters they can remember, subjects can report on average 4-5 /12 characters, an accuracy of 33-40%.



Partial report: However, if subjects are cued to report just on *one particular row* (top, middle, or bottom) subjects can correctly remember 3-4 characters from that row, an accuracy of 75-100%, but few if any others. This effect persisted for up to 1000ms in Sperling's original experiment.





Sperling Experimentation

B	H	D
C	J	G
I	E	A



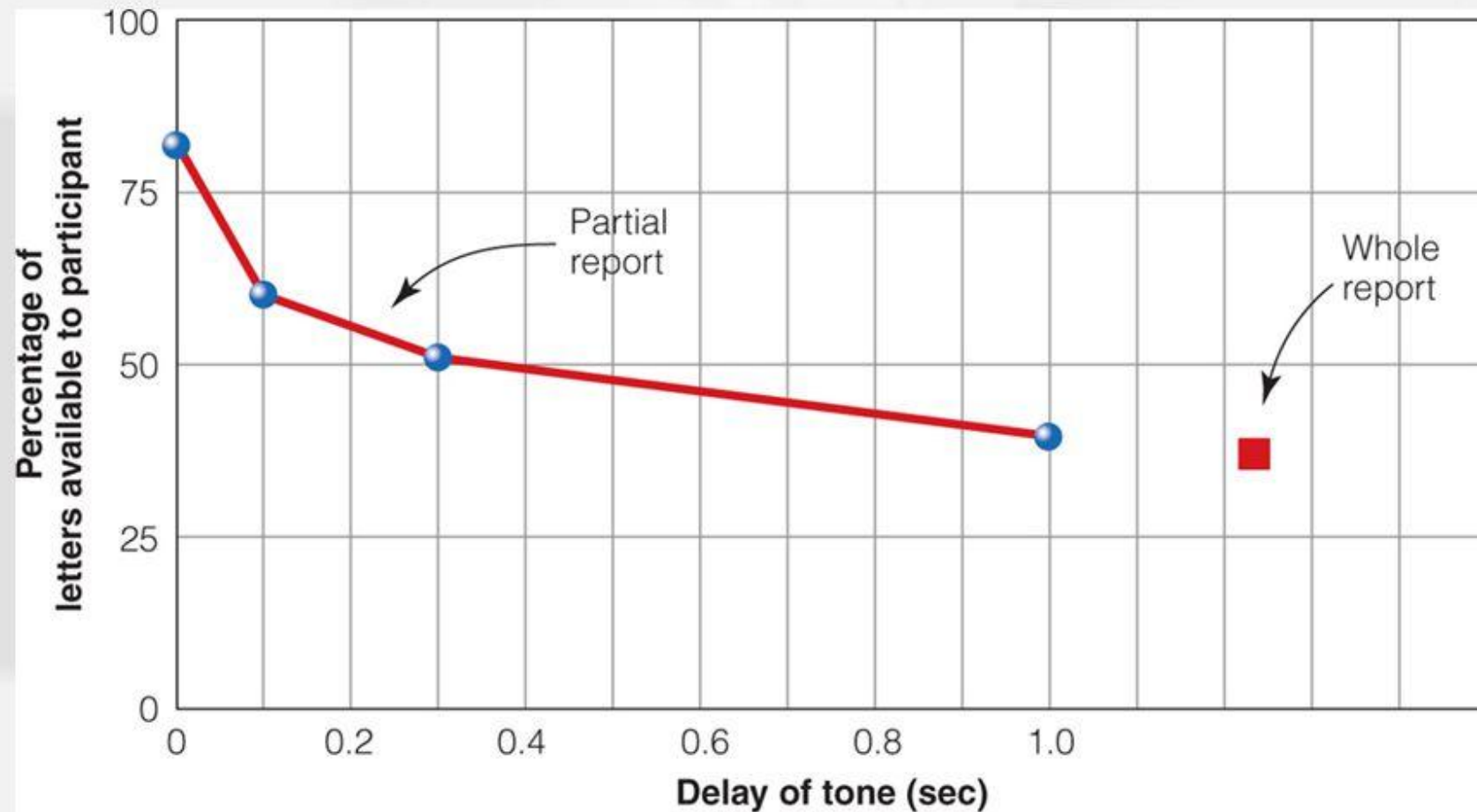
Sperling Experimentation



F	C	H	D
J	R	P	O
D	N	B	A



PRACTICE SESSION



(c)2011 Cengage Learning

Caption: 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).



➡ Short term memory



STM

- Short-term memory, also known as **primary or active memory**, includes the information we are **currently** aware of or thinking about.
- Most of the information kept in short-term memory will be stored for approximately 20 to 30 seconds.
- Its capacity is also very limited.



Capacity of STM

Memory Span

The longest sequence that a person can typically recall

Present a sequence of 2 to 10 digits and measure the number of items Ps can recall *in order*

STM Capacity

- George A. Miller (1956), when working at Bell Laboratories, conducted experiments showing that the store of short-term memory was 7 ± 2 items (the title of his famous paper, "The magical number 7 ± 2 ").
- Modern estimates of the capacity of short-term memory are lower, typically of the order of 4–5 items; however, memory capacity can be increased through a process called chunking.
- For example, in recalling a ten-digit telephone number, a person could chunk the digits into three groups: first, the area code (such as 123), then a three-digit chunk (456) and lastly a four-digit chunk (7890). This method of remembering telephone



Capacity of STM

Chunking
Example

CA

TBU

SR

ATDO

G





Capacity of STM

Chunking
Example

CA

TBU

SR

ATDO


G

CAT

BUS

RAT


DOG



Mechanism of Forgetting

Interference vs. Decay

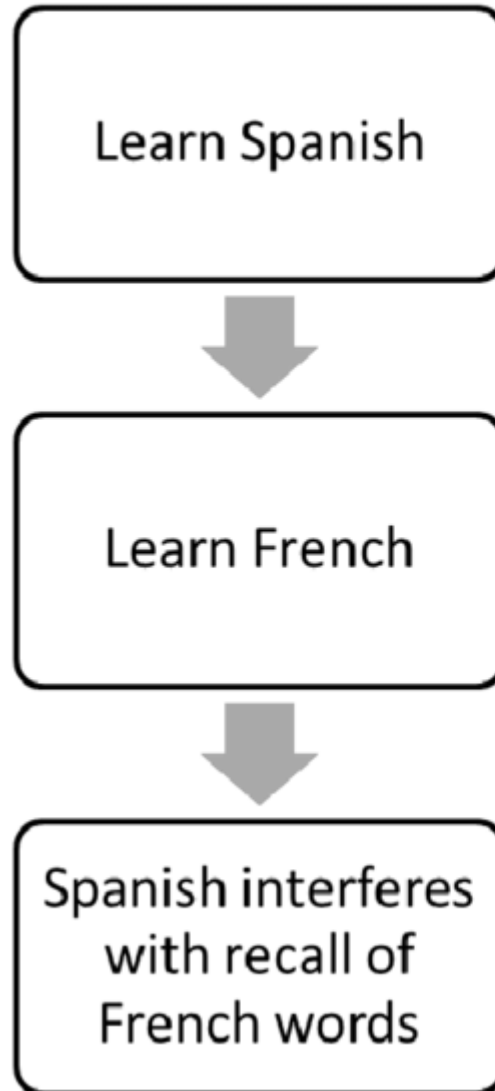
- **Decay** – according to this view, information simply “disappears” from STM
- “Spontaneous loss of information over time”



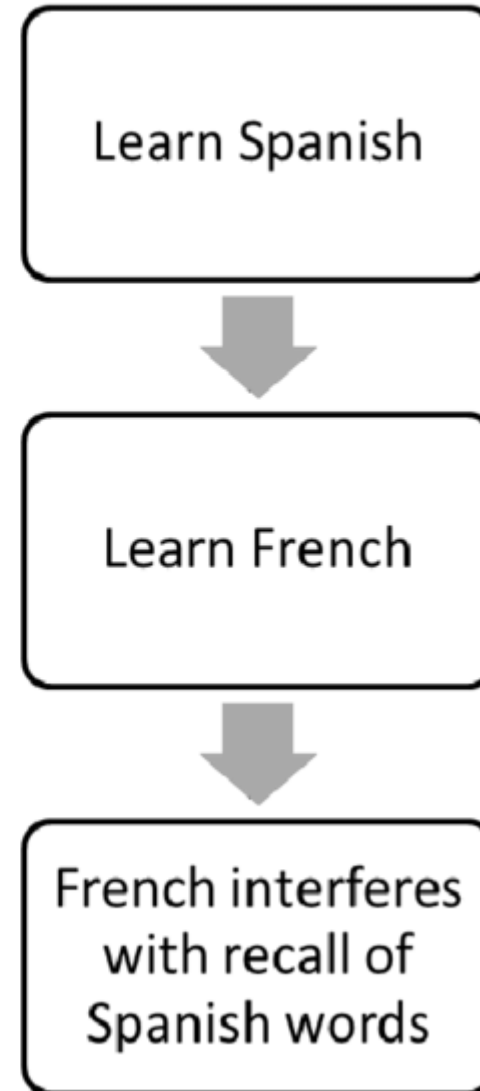
Interference vs. Decay

1. **Interference** – according to this view, there is a competition among information
2. When old information interferes with new information you experience *proactive interference*
3. When new information interferes with old information you have *retroactive interference*

Proactive interference



Retroactive interference





STM: Brown-Peterson Task

Presented participants with three consonants (e.g. CHJ) followed by a number

Ps were then asked to count backwards by threes from the #

This *distracter task* keeps Ps from *rehearsing* the letters

Distracter task lasted for 3, 6, 9, 12, 15 or 18 seconds (*retention interval*)




STM: Brown-Peterson Task

ZBA



STM: Brown-Peterson Task

367





STM: Brown-Peterson Task

PGL



STM: Brown-Peterson Task

597






STM: Brown-Peterson Task

DGA

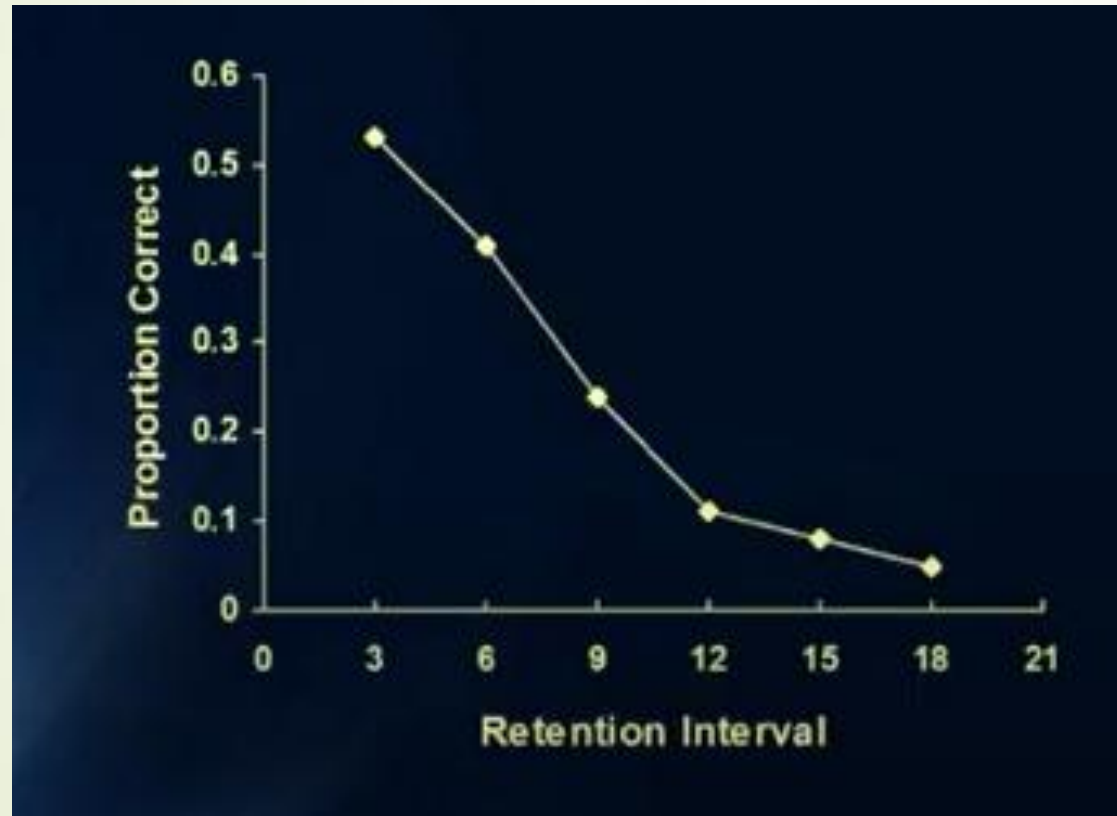


STM: Brown-Peterson Task

223



STM: Brown-Peterson Task



Results – performance declined as a function of retention interval



Working Memory

Working Memory is “the neural structures and cognitive processes that maintain the accessibility of information for short periods of time in an active conscious state”

A short-term memory system which holds information over a short period of time

A limited capacity system

The current contents of working memory are thought to be equivalent to conscious awareness.

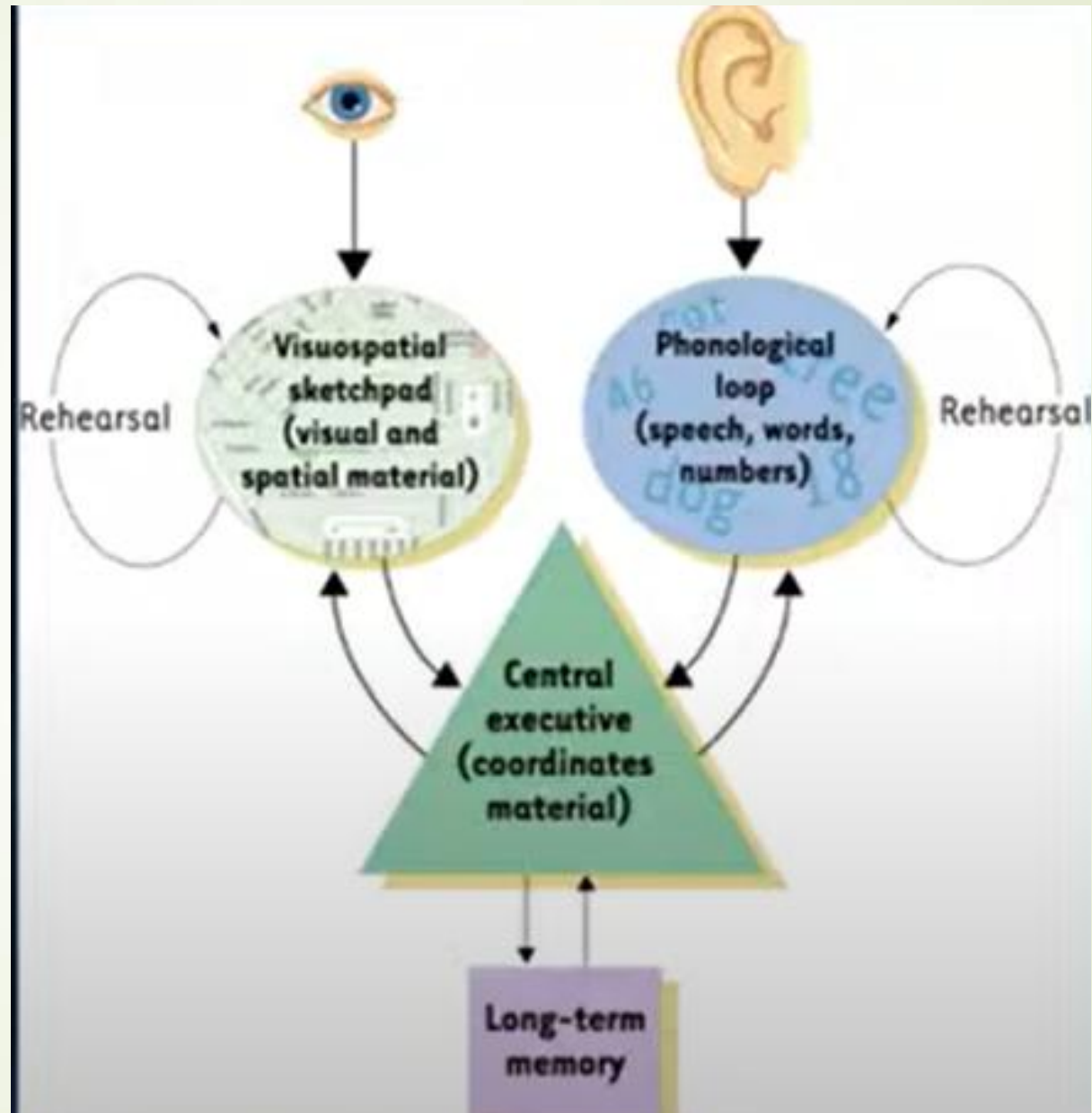


Working Memory

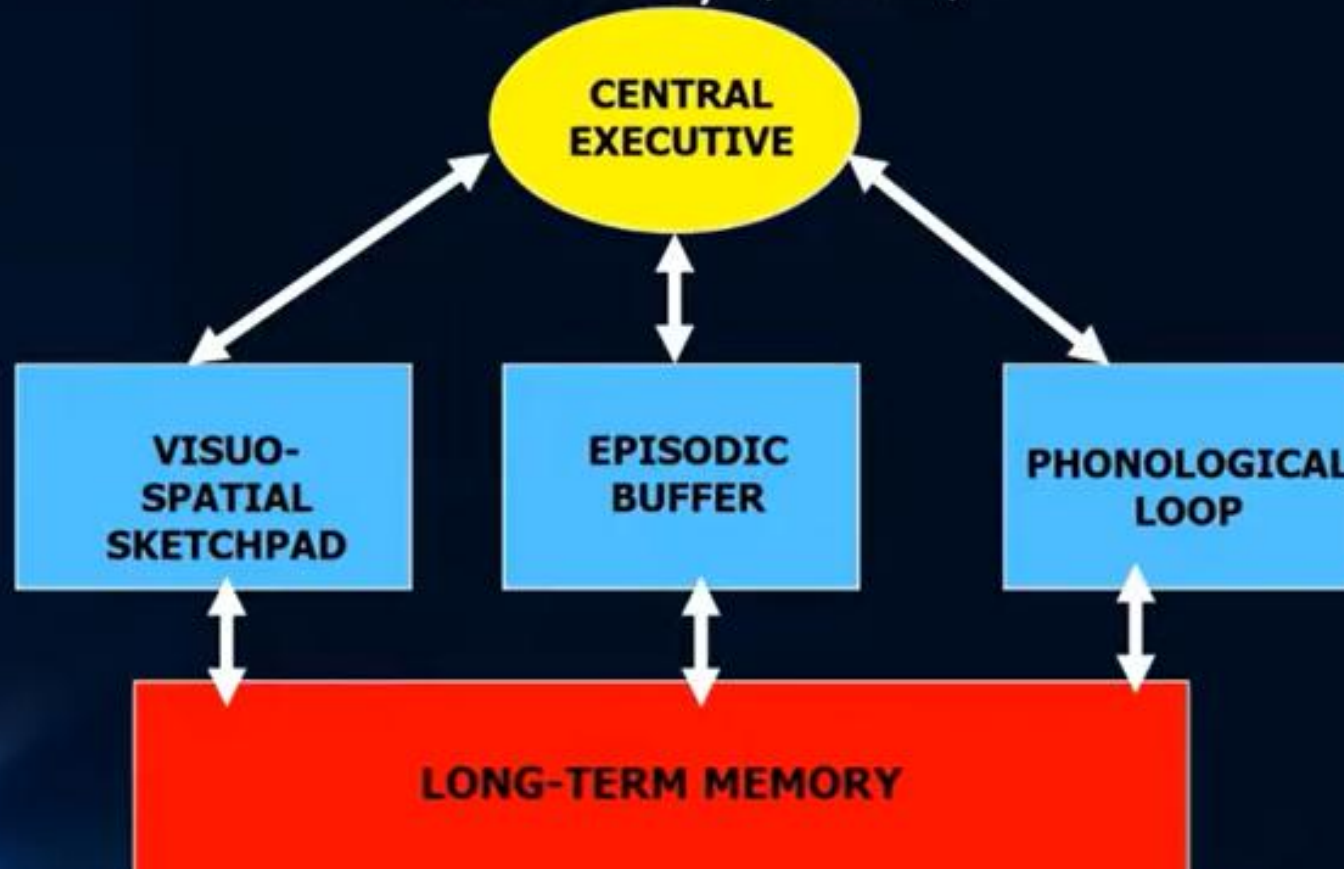
Baddeley's Model of Working Memory

Working Memory Components

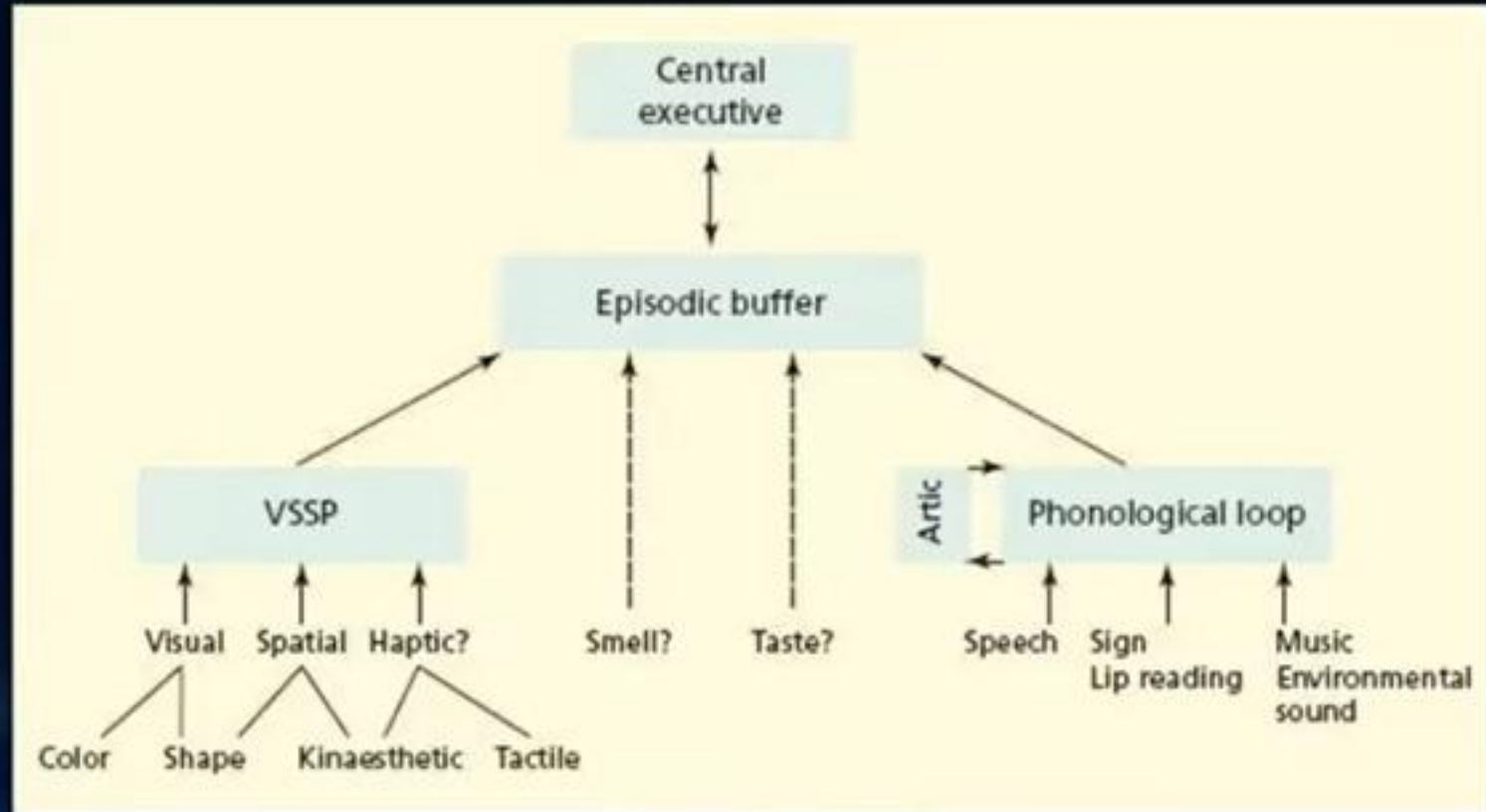
1. The Phonological Loop
 - The phonological store
 - The articulatory rehearsal process
2. The Visuospatial Sketchpad
3. The Episodic Buffer
4. The Central Executive



Baddeley's Model of Working Memory (2000)



Baddeley's Model of Working Memory (2012)



Long-Term Memory

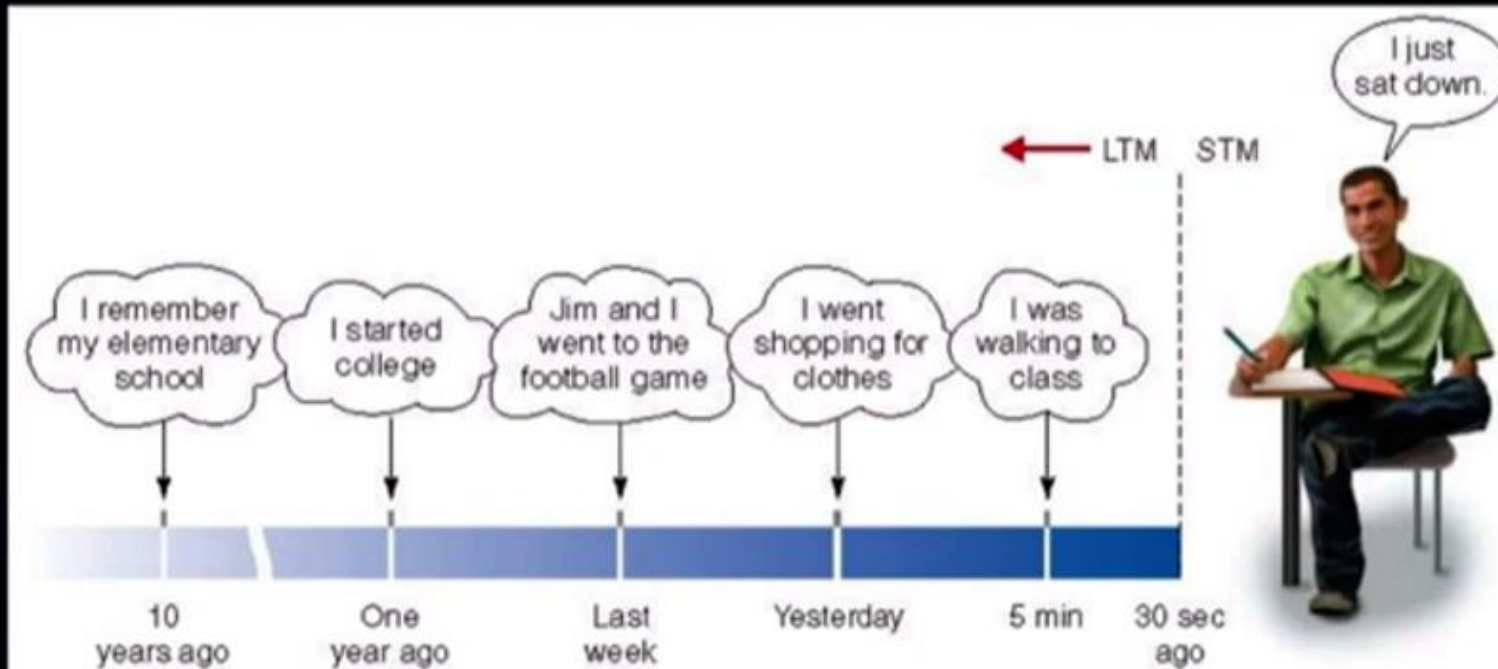


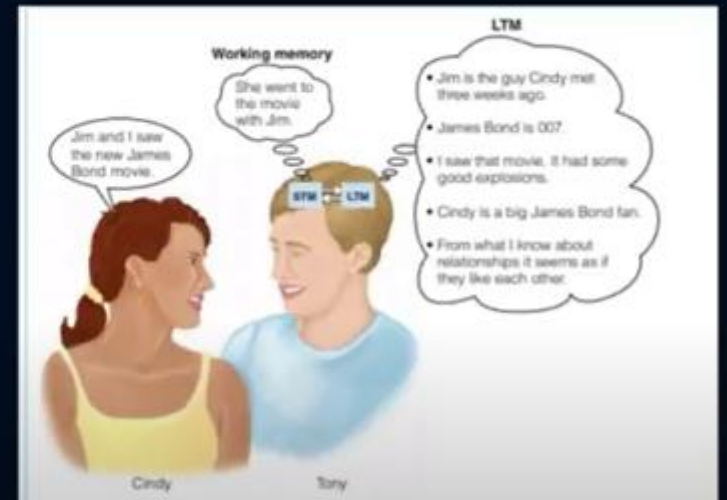
Figure 6.1 Long-term memory covers a span that stretches from about 30 seconds ago to your earliest memories. Thus, all of this student's memories, except the memory "I just sat down" and anything the student was rehearsing, would be classified as long-term memories. © Cengage Learning

Long term memory

- Long-term memory refers to **the storage of information over an extended period**. This type of memory tends to be stable and can last a long time—often for years.

Interactions between Working and Long-term Memory

- A. Information is encoded into LTM and retrieved from LTM via WM
- B. Elaboration occurs when we encode experiences in WM by linking to information from LTM



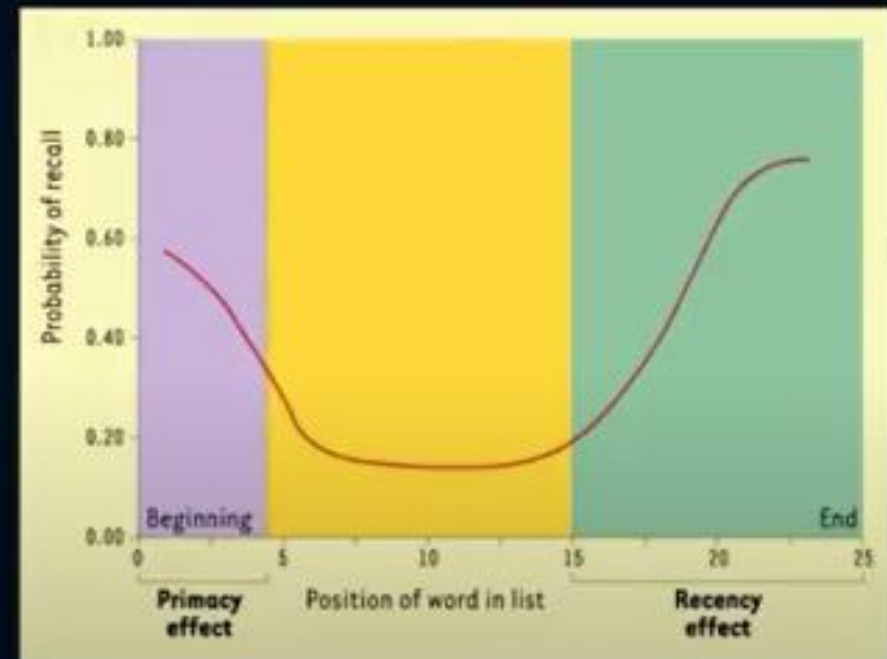
Long term memory

Interactions between Working and Long-term Memory

Working Memory and the Serial Position Effect

The Serial Position Curve

– the observation that participants remember items well from the beginning and end of a list, but not the middle.





Long term memory

Interactions between Working and Long-term Memory

Working Memory and the Serial Position Effect

1. **The Serial Position Curve**
2. **Primacy Effect** – the observation that memory is usually superior for items at the beginning of a list – thought to be caused by encoding into LTM
3. **Recency Effect** – memory is usually superior for items at the end of a list, thought to be caused by these items being available in WM



Types of LTM

Episodic Memory

The neurocognitive memory system that encodes, stores and retrieves memories of our personal experiences.

Often conceived of as *context dependent* memory

Can be thought of as *mental time travel*



Episodic Memory


- Episodic memory can be described as a mental diary which receives and stores information about our experiences and events. They are autobiographical (personally experienced events).
- These memories are dependent on 'time referencing'; linked to the time in which they occurred. E.g recalling your first day at school etc.
- Recall of episodic memory is also dependent on the context in which the learning took place.
- Input is continuous so we experience a whole episode rather than a section of the memory.
- Episodic memory enables us to 'time travel' and to relive past events that are from personal experiences.



Types of LTM

Semantic Memory

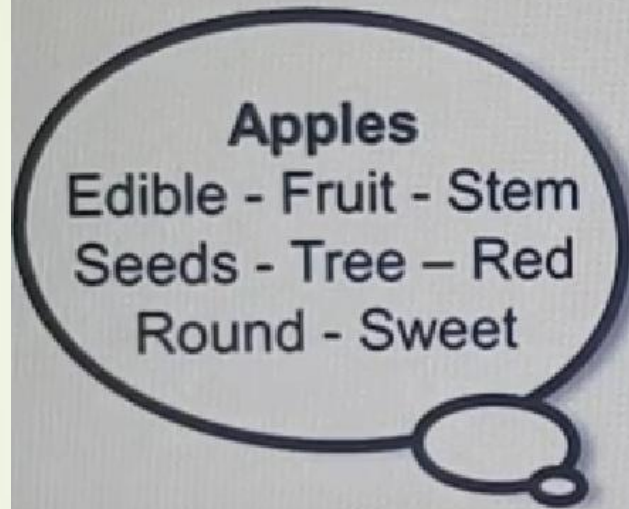
- A. The neurocognitive memory system that encodes, stores and retrieves information concerning knowledge of the world
- B. All of our knowledge is essentially our semantic memory, such as:
 - 1. What is a duck?
 - 2. What is the capitol of Maine?
 - 3. What ingredients are included in a margarita?
- C. These are memories which are *independent of learning context*



The relationship between episodic and semantic memory

- A. Semantic memories start out as episodic memories
- B. Eventually, they lose their connection to time and place
- C. The goal of education then, is to create semantic memories, using episodic memory

Semantic Memory



object knowledge learned
over many interactions

Episodic Memory



memory for specific events
that you have experienced





Semantic vs. Episodic

	Semantic	Episodic
Nature of memory	Mental encyclopaedia	Mental diary
Time referencing	Independent of time referencing.	Time and context referenced
Retrieval and Forgetting	Retrieval possible without learning. Not cued recall	Retrieval using cues which are encoded at the time of learning. Forgetting due to retrieval cue failure.



Semantic memory

Introduction to Semantic Memory

What is semantic memory?

1. Permanent memory store of our world knowledge
2. Different from episodic memory – no representation of when or where we learned the information
3. Examples
 - What is the capitol of Colorado?
 - How many legs does a horse have?
 - What color is a canary?



Semantic memory

New terminology

1. Concepts

- Mental representations
- Often “the fundamental unit of thought”
- “An idea that includes all that is characteristically associated with it” (Medin, 1989)

2. Proposition

- The relationship between concepts
- E.G.
 - A canary is yellow
 - A canary is a bird
 - A bird has wings
 - A bird is an animal



Semantic memory

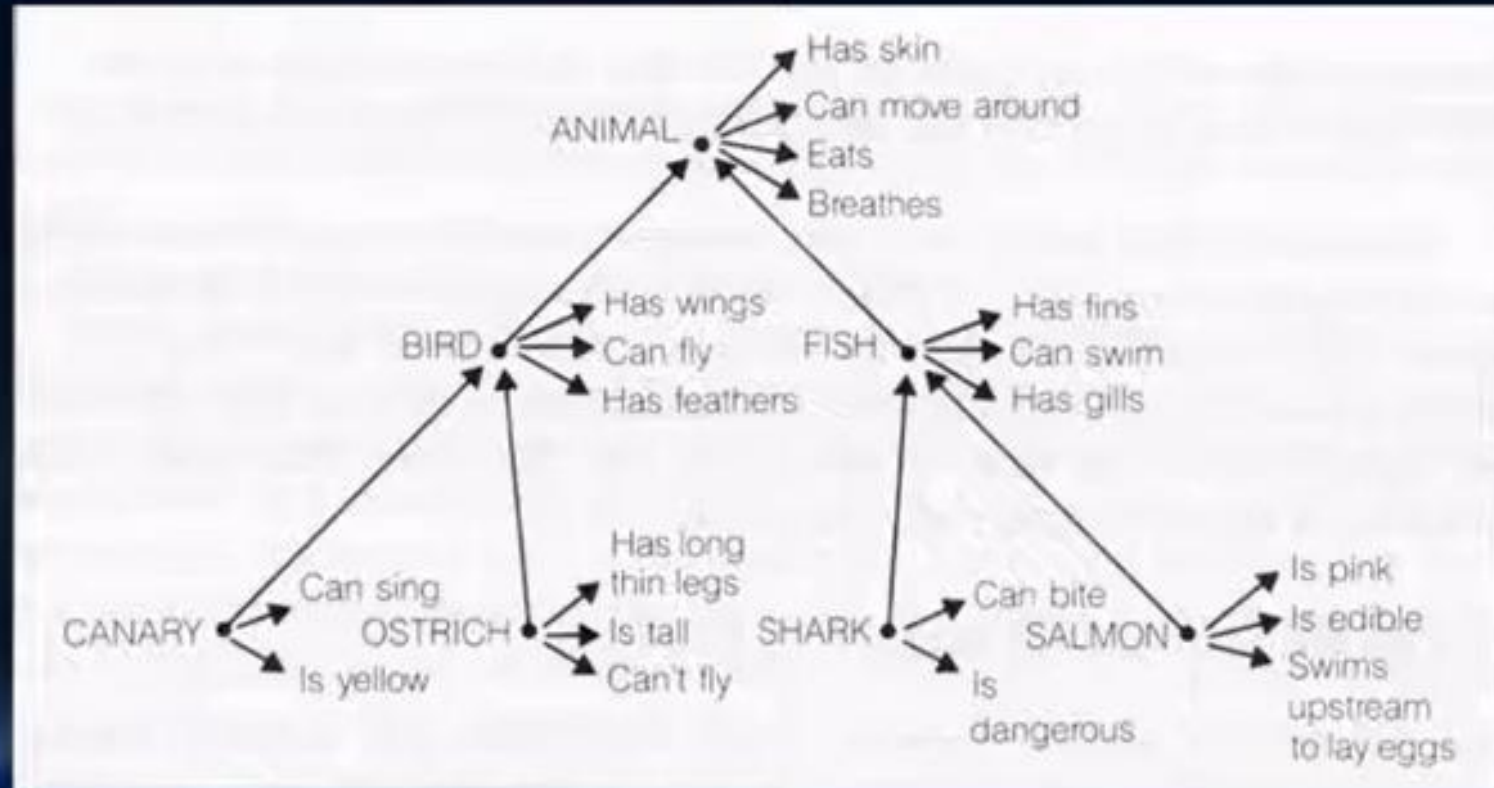
The Collins & Quillian Hierarchical Model

Key Properties

1. **Network**: An interrelated set of concepts / body of knowledge.
2. **Node**: A point or location in the network representing a single concept.
3. **Pathways**: associations between concepts (propositions) that are directional.
 - “ISA” pathways denote category membership – “Canary is a bird”
 - Property pathways describe properties of concepts “Bird has feathers”

Semantic memory

Sample Portion of the Semantic Network





Semantic memory

The Collins & Quillian Model

Spreading Activation

1. The mental activity of accessing and retrieving information from the network.
2. Takes passive concepts (those not currently in working memory) and activates them (puts them in working memory).
3. Activation then spreads to related nodes (e.g., activation to the doctor node would also spread to the nurse node).



Semantic memory

The Collins & Quillian Model

Key Features of the Model

1. Hierarchical – concepts are arranged in a *hierarchy*
2. This allows for *cognitive economy* – removes any redundancy
3. Takes time for activation to spread across *inactive nodes*

Semantic memory: Activation

