Lecture 9
Cognitive Processes – Part I

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In the Last Lecture

- Vision
  - Color Theory
  - 3D Vision
  - Reading
- Hearing
  - Human Ear
  - Processing Sound
- Touch (Haptic Perception)
  - Skin Physiology
  - Types of haptic senses
- Movement
  - Movement Perception

In Today's Lecture

- Attention

- Models of Attention

- Consequences

- Memory

- A Model Of Memory
  - Sensory Memory
  - Short Term Memory
  - Long Term Memory
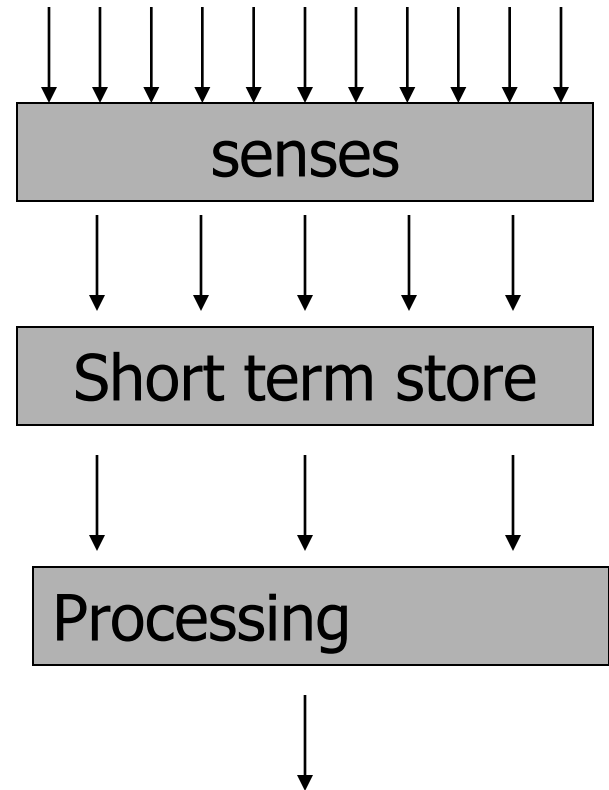
Attention

- What is attention.
  - many competing stimuli, but.
  - only limited capacity.
  - therefore need to focus, and select.
- Visual attention.
  - based on location and colour.
- Auditory attention.
  - based on pitch, timbre, intensity, etc.
- Color can be a powerful tool to improve user interfaces, but its inappropriate use can severely reduce the performance of the systems we build

Models of Attention

- Divided attention

Available capacity

Possible activities

- Focused attention

senses

Short term store

Processing
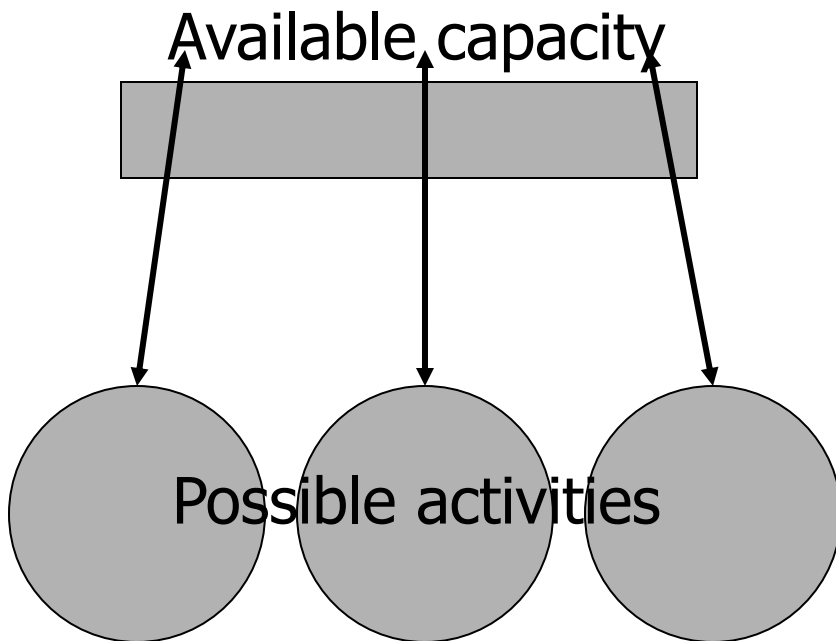
Focused Attention

- Only one thing can be the focus of attention

- Attention focus is voluntary or involuntary

- Factors affecting attentional focus
  - meaningfulness
  - structure of display
 - use of color, intensity,
  - use of modalities

Example 1

City	Hotel	Area Code	Phone	Rates	
				Single	Double
Lahore	Holiday Inn	042	6300634	2000	4000
Lahore	Sheraton	042	5456322	1800	3500
Lahore	Perl Continental	042	4565654	2500	5000
Karachi	Holiday Inn	021	1645656	2000	4000
Karachi	Sheraton	021	6545646	1800	3500
Karachi	Perl Continental	021	9545656	2500	5000


```
Islamabad: Holiday Inn
(051) 4544556 S:2000 D:4000
Islamabad: Sheraton
(051) 2135466 S:1500 D:3500
Islamabad: Pearl Continental
(051) 6565322 S:3000 D:6000
Faisalabad: Holiday Inn
(041) 4544556 S:2000 D:4000
Faisalabad: Sheraton
(041) 2135466 S:1500 D:3500
Faisalabad: Pearl Continental
(041) 6565322 S:3000 D:6000
```

Attention and Automatic Action

- Frequent activities become automatic.
- Carried out without conscious attention.
- User does not make conscious decision.

Do you want to save the changes you made to 'com3210-lec07-v0.ppt'?

[Don't Save]   [Cancel]   [Save]
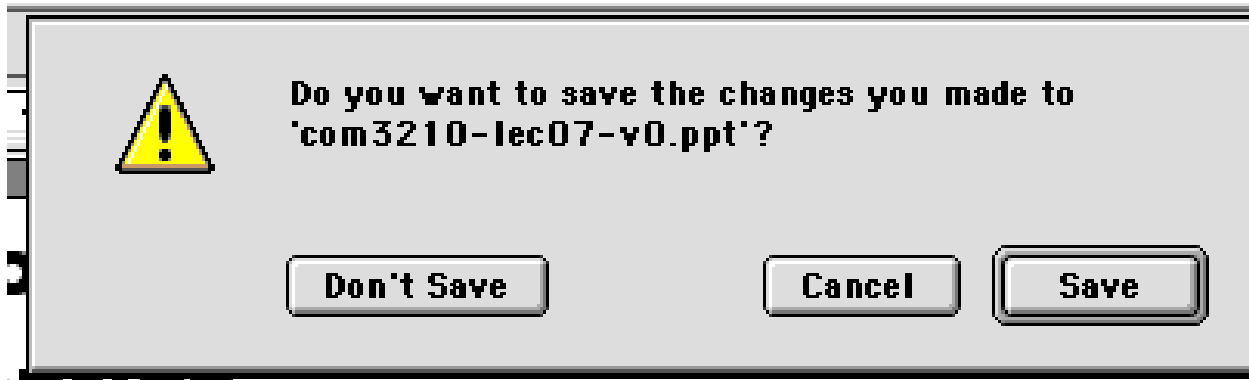
- Requiring confirmation does not necessarily reduce errors!

Consequences

- Design to assist attentional focus in the right place.
- Help user to.
  - attend his/her task not the interface.
  - decide what to focus on, based on their tasks, interest,etc.
  - to stay focused, do not provide unnecessary distractions.
  - structure his/her task, e.g. help
- Create distraction, when really necessary!
- Use alerts (only) when appropriate!

Consequences

- Make information salient when it needs attending to

- Use techniques that make things stand out like colour, ordering, spacing, underlining, sequencing and animation

- Avoid cluttering the interface - follow the google.com example of crisp, simple design

- Avoid using too much colors because the software allows it
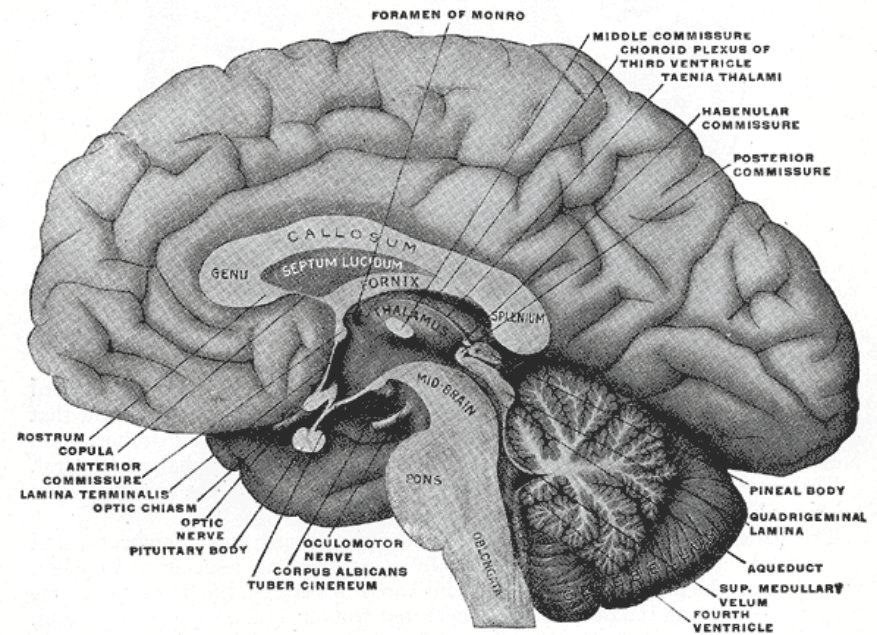
An example of over-use of graphics

Our Situation

- State the bad news
- Be clear, don't try to obscure the situation

Memory

- Cognitive models of memory
- Activation in memory
- Implications of memory models
- Applications of memory models

Memory

- Involves encoding and recalling knowledge and acting appropriately

- We don't remember everything - involves filtering and processing

- Context is important in affecting our memory

- We recognize things much better than being able to recall things
  - The rise of the GUI over command-based interfaces

- Better at remembering images than words
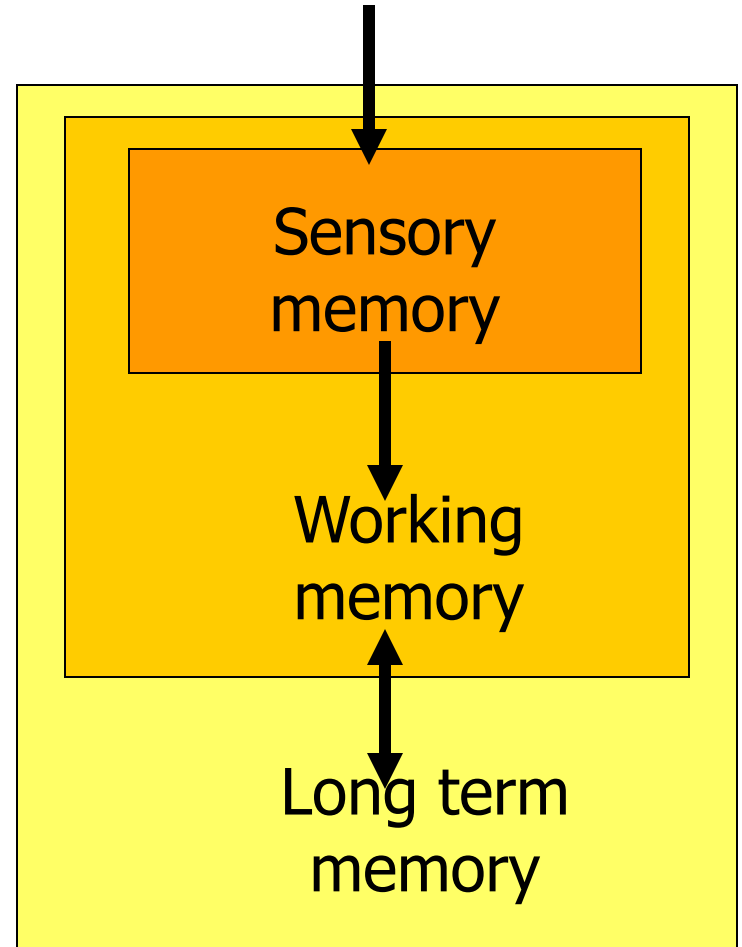 - The use of icons rather than names

A Model of Memory

- Three memory stores
  - sensory memory
    - input buffer
    - visual or acoustic
  - short term memory
    - 'scratchpad' store
    - visual or acoustic
  - Long term memory
    - stores facts and meanings
    - semantically organised

Sensory memory

↓

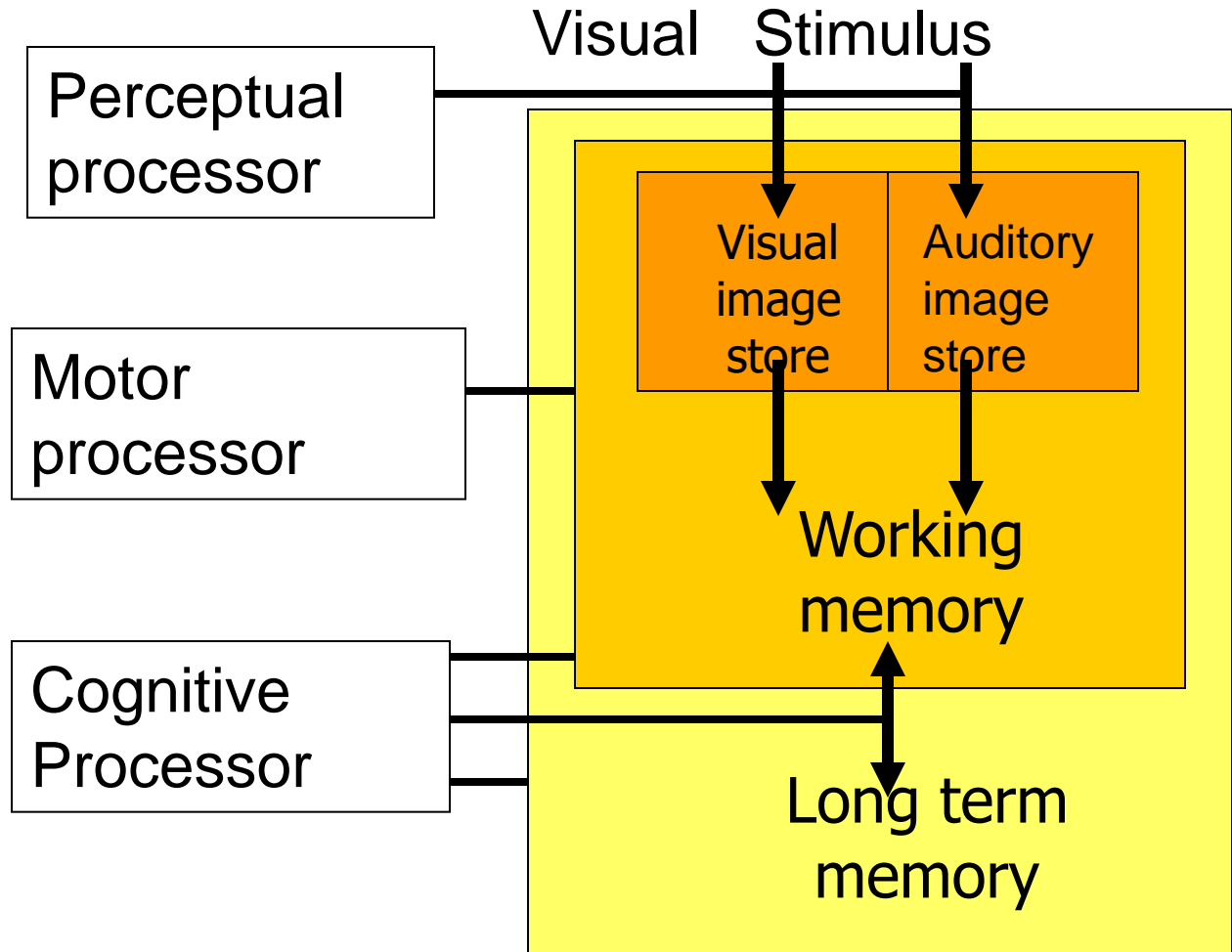Short term memory

↓

Long term memory
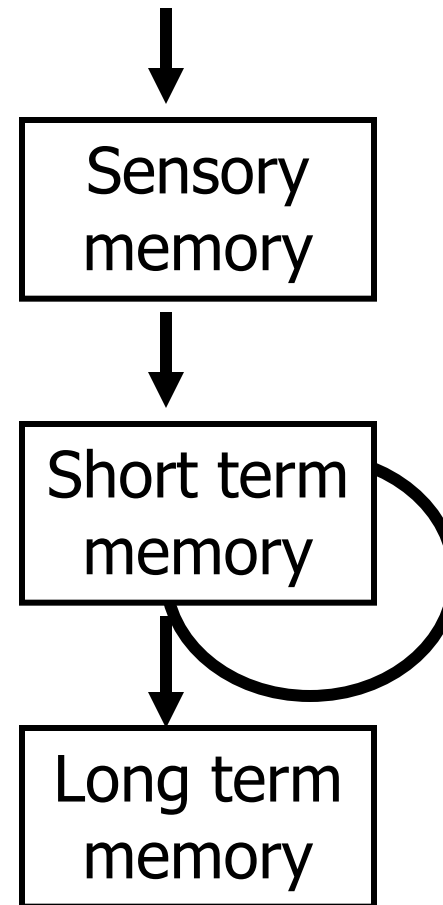
Revised Memory Model

- Working memory is a subset of LTM.

- Items are semantically linked.

- items in working memory are activated.

- activation is supplied from other linked chunks and from sensory input.

Revised Human Processor Model and Related Memory

Visual   Stimulus

Perceptual processor

Motor processor

Cognitive Processor

Visual image store

Auditory image store

Working memory

Long term memory

Sensory Memory/ Perceptual Store

- Visual and auditory impressions
  - visuospatial sketchpad, phonological loop

- Very brief, but veridical representation of what was perceived
  - Details decay quickly (~.5 sec)
  - Rehearsal prevents decay
  - Another task prevents rehearsal

- Types
  - Iconic: for visual stimulus (fireworks trail, finger moving)
  - Aural: for auditory stimulus (repeat a question)
  - Haptic: touch stimulus

Sensory Memory/ Perceptual Store

- Buffers for stimuli received through senses
    - iconic memory: visual stimuli
    - echoic memory: aural stimuli
    - haptic memory: tactile stimuli
- Examples
    - "sparkler" trail, finger moving
    - stereo sound
- Continuously overwritten

Short Term Memory

- Display format should match memory system used to perform task

- New info can interfere with old info

- Scratch-pad for temporary recall

  - rapid access ~ 70ms

  - rapid decay ~ 200ms

  - limited capacity - 7± 2 chunks (chunk formation called "closure")

Short Term Memory - Example

- Memory flushing
  - ATM machine provides ATM card to user before cash

Short Term Memory

- Example

35 x 6

Step 1: 30 x 6

Step 2: 5 x 6

Ans: step 1 + step 2

Short Term Memory

- Example

212348278493202 (difficult)
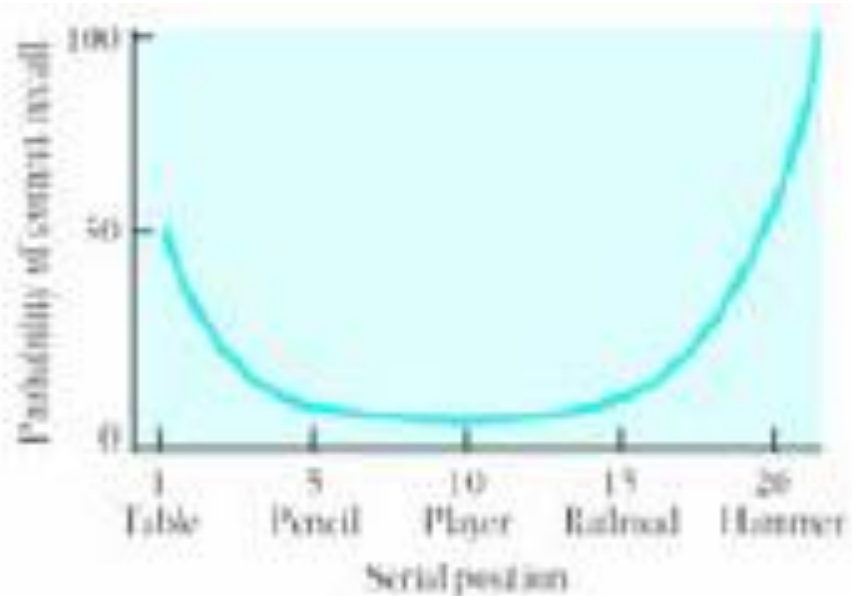
0121 414 2626 (easy)

HEC ATR ANU PTH ETR EET
(The Cat Ran Up The Tree)

Serial Position Curve (without distracter)

- How does the position in the list effect recall?

- Serial Position Curve

Components of the serial position curve

- **Recency effect**
  - better recall for items at the end of the list because these items are still active in STM (and possibly SM) at time of recall

- **Primacy effect:**
  - better recall for items at the beginning of the list (because these items have been rehearsed more frequently than other items and thus have a greater chance of being placed in LTM)

Chance of recall

Immediate recall

Recall after 30 s

Position in list

LTM

STM
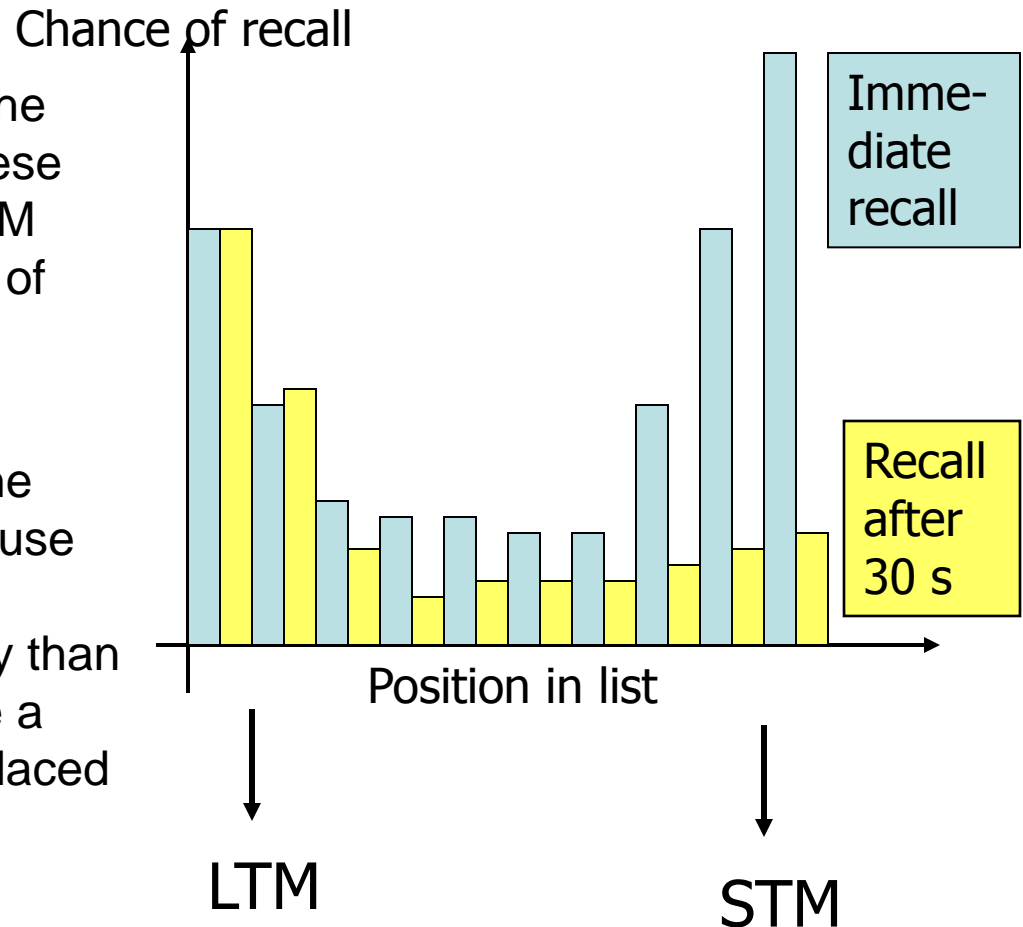
Serial Position Curve

- The distracter task diminish the recency effect since the items at the end of the list no longer in the STM

- Primacy effect is still present since the information in LTM is not effected by distracter task
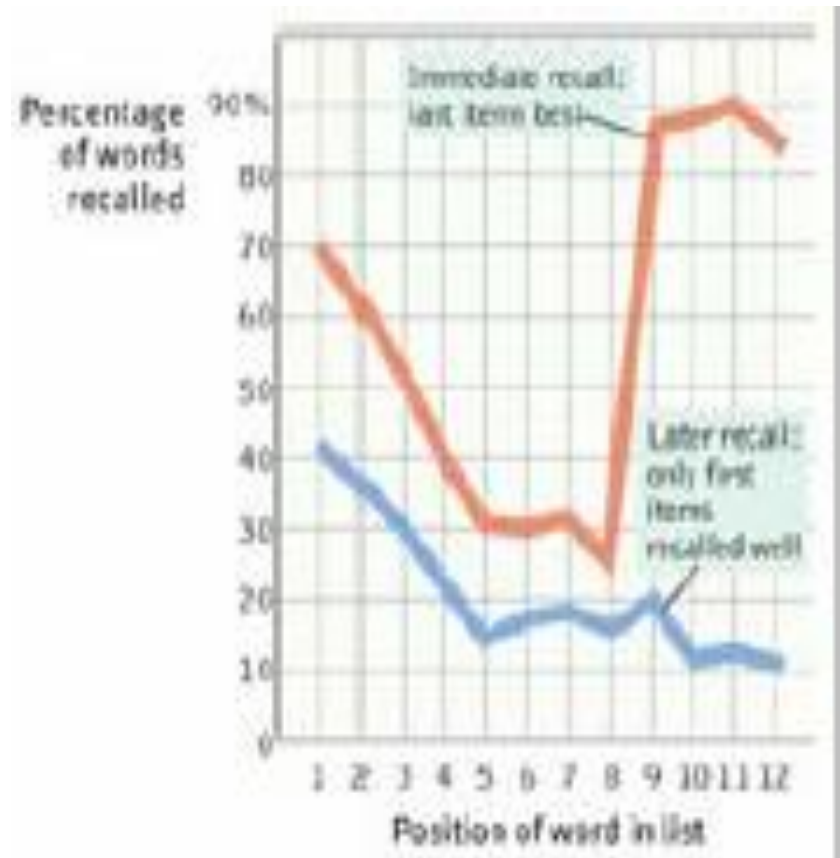
Long Term Memory

- Organized as a network of connected chunks of knowledge

- active chunks are in the working memory

- activation spreads through the network
  - strength of connection
  - retrieval of items into WM

- Repository for all our knowledge
  - slow access ~ 1/10 second
  - slow decay, if any
  - huge or unlimited capacity

Long Term Memory

- Example
  - the dog chewed the food
  - the cat stole the food
  - the dog chased the cat
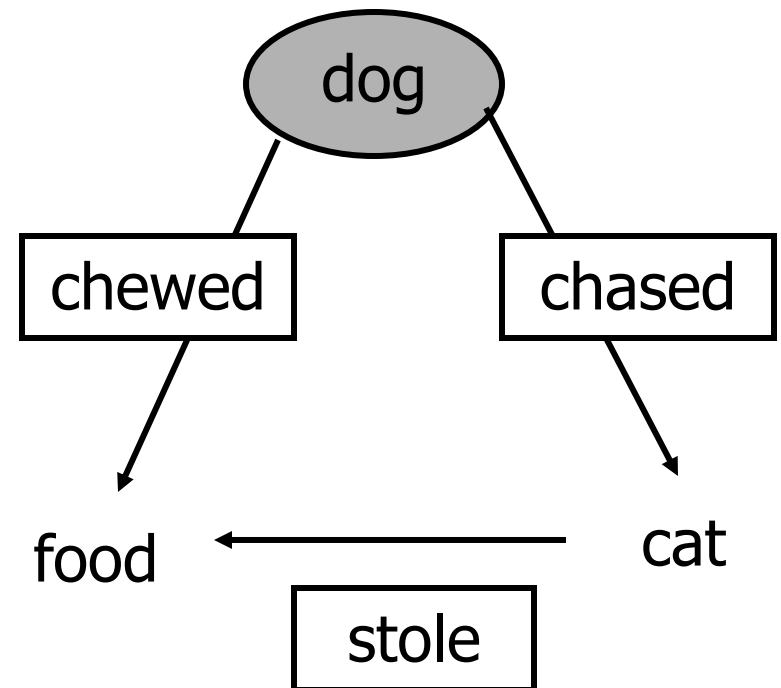
LT Memory Structure

- Episodic memory
  - Events & experiences in serial form
    - Helps us recall what occurred

- Semantic memory
  - Structured record of facts, concepts & skills
    - One theory says it's like a network
    - Another uses frames & scripts (like record structs)

semantic LTM derived from episodic LTM
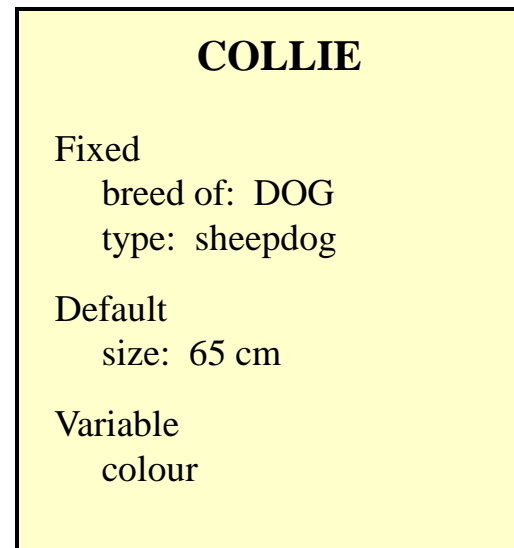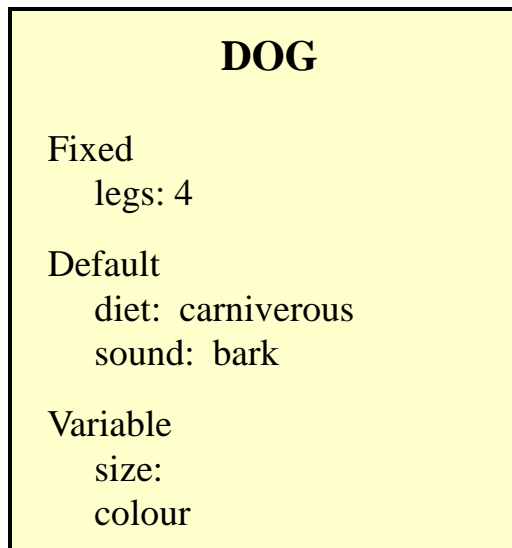
LT Memory Structure

- Semantic memory structure
  - provides access to information
  - represents relationships between bits of information
  - supports inference

- Model: semantic network
  - inheritance – child nodes inherit properties of parent nodes
  - relationships between bits of information explicit
  - supports inference through inheritance

LTM - semantic network
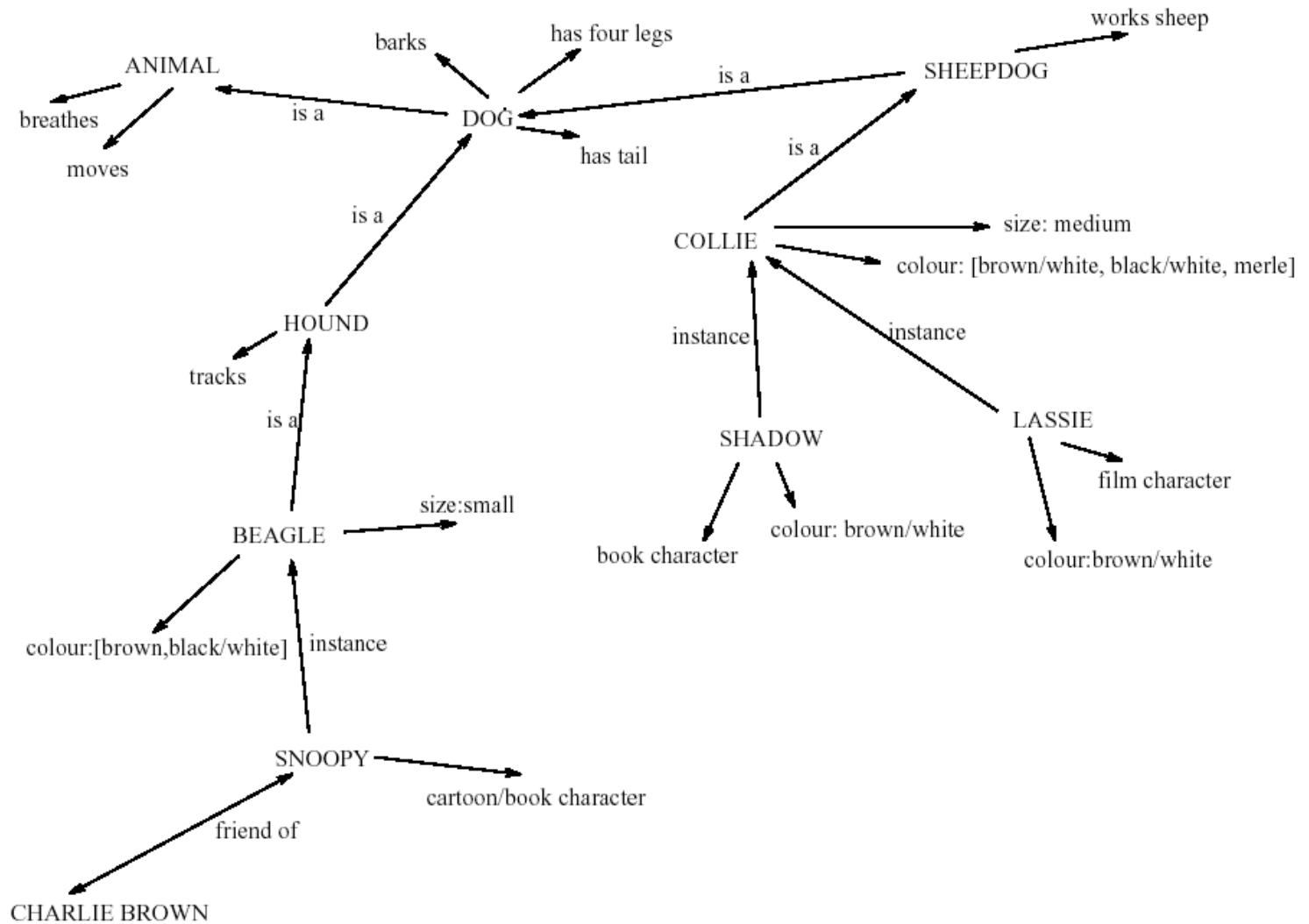
Models of LTM - Frames

- Information organized in data structures

- Slots in structure instantiated with values for instance of data

- Type–subtype relationships

DOG
Fixed   legs: 4

Default
  diet: carniverous
  sound: bark

Variable
  size:
  colour

COLLIE

Fixed
  breed of: DOG
  type: sheepdog

Default   size: 65 cm
Variable   colour

Models of LTM - Scripts

- Model of stereotypical information required to interpret situation
- Script has elements that can be instantiated with values for context

"John took his dog to the surgery. After seeing the vet he left."

Script for a visit to the vet

Entry conditions: *dog ill*
vet open
owner has money

Result: *dog better*
owner poorer
vet richer

Props: *examination table*
medicine
instruments

Roles: *vet examines*
diagnoses
treats
owner brings dog in
pays
takes dog out

Scenes: *arriving at reception*
waiting in room
examination
paying

Tracks: *dog needs medicine*
dog needs operation

Models of LTM - Production System

- Representation of procedural knowledge
    - Knowledge of how to do something

- Condition/action rules stored in LTM
    - Info comes to STM
    - if condition is matched in LTM
    - then use rule to determine action.

IF dog is wagging tail
THEN pat dog

IF dog is growling
THEN run away

LTM processes

- 3 processes
    - Storage
    - Forgetting
    - Information retrieval

LTM - Storage of information

- rehearsal
  - information moves from STM to LTM

- total time hypothesis
  - amount retained proportional to rehearsal time

- distribution of practice effect
  - optimized by spreading learning over time

- structure, meaning and familiarity
  - information easier to remember

LTM - Forgetting

decay

– information is lost gradually but very slowly

interference

– new information replaces old: retroactive interference
– old may interfere with new: proactive inhibition

so may not forget at all memory is selective …

… affected by emotion – can subconsciously `choose' to forget

Memory Characteristics

- Things move from STM to LTM by rehearsal & practice and by use in context

Unclear if we ever
really forget something

Lack of use

- We "forget" things due to decay and interference

Similar gets in
way of old

LTM - retrieval

- ## recall
  - information reproduced from memory can be assisted by cues, e.g. categories, imagery

- ## recognition
  - information gives knowledge that it has been seen before
  - less complex than recall - information is cue

The problem with the classic '7±2'

- George Miller's theory of how much information people can remember

- People's immediate memory capacity is very limited

- Many designers have been led to believe that this is useful finding for interaction design

What some designers get up to…

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page
    - But this is wrong? Why?

Why?

- Inappropriate application of the theory

- People can scan lists of bullets, tabs, menu items till they see the one they want

- They don't have to recall them from memory having only briefly heard or seen them

- Sometimes a small number of items is good design

- But it depends on task and available screen estate

More appropriate application of memory research

- File management and retrieval is a real problem to most users

- Research on information retrieval can be usefully applied

- Memory involves 2 processes
  - recall-directed and recognition-based scanning

- Recall is based on context
  - Not recognizing neighbour in bus

- Recognition rather than recall
  - Browser bookmarks
  - GUI interface icons

File Management

- File management systems should be designed to optimize both kinds of memory processes

- Facilitate existing memory strategies and try to assist users when they get stuck

- Help users encode files in richer ways
  - Provide them with ways of saving files using colour, flagging, image, flexible text, time stamping, etc

People

- <u>Good</u>
  - Infinite capacity LTM
  - LTM duration & complexity

- <u>Bad</u>
  - Limited capacity STM
  - Limited duration STM
  - Unreliable access to LTM
  - Error-prone processing
  - Slow processing

Computer is opposite!
Allow one who does it
best to do it!
(Function allocation)

Next Lecture

- Learning

- Problem Solving

- Errors

- Emotions