King Saud University

College of Engineering

IE – 341: "Human Factors"

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Chapter 3. Information Input and Processing

Part – 5: Memory – Attention

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Contents

- Memory
- Attention

Memory

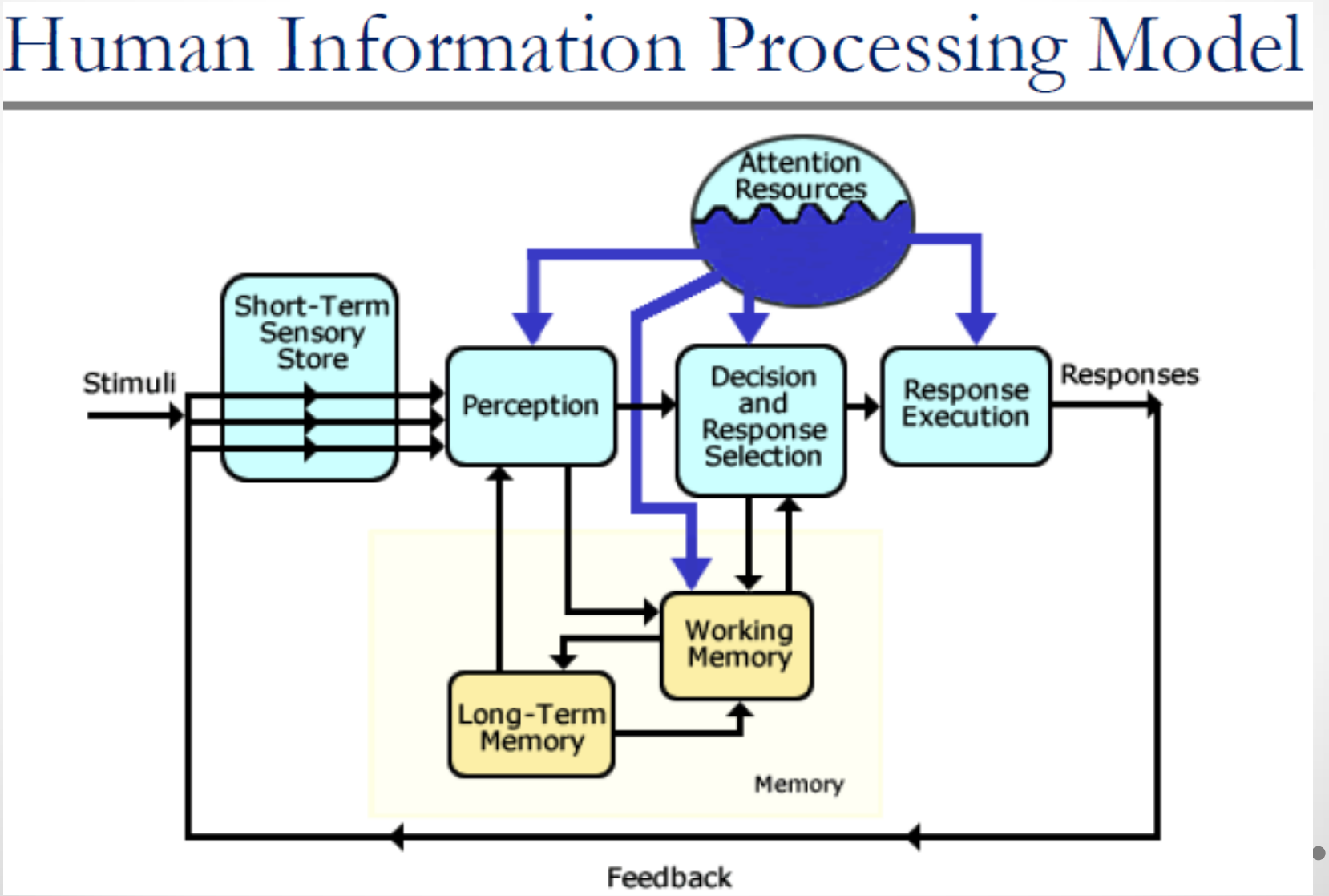
Memory

- Memory: storage of information

- Human Memory Subsystems
  1. Sensory storage
  2. Working memory
  3. Long-term memory

- Discuss here
  - Each of 3 subsystems (*see next slide*)
  - How information is coded in each
  - Practical applications in each subsystem

Cont. Memory


Human Information Processing Model
Attention Resources
Short-Term Sensory Store
Stimuli
Perception
Decision and Response Selection
Response Execution
Responses
Working Memory
Long-Term Memory
Memory
Feedback

Cont. Memory

1. Sensory Storage

- Mechanism
  - Part of each sensory channel
  - Keeps record of stimulus for short period after stimulus is finished then fades
  - Allows further processing of stimulus
  - Associated with visual system
    - "iconic storage"
    - Lasts $< 1\,s$
  - Associated with auditory system
    - "echoic storage"
    - Last: few seconds

- Information Representation:
  - Information not coded
  - Info. kept in original representation
  - Sensory representation cannot be prolonged
  - To keep for longer time $\Rightarrow$ transfer to working memory

Cont. Memory

2. Working Memory (aka Short-term memory)

- Information coded as
  - Visual code
  - Phonetic code
  - Semantic code
  - Note, all 3 can exist at same time in WM for particular stimulus
- Visual and phonetic codes
  - Visual or auditory representations of stimuli
  - Generated:
    - Internally from long-term memory (without hearing or seeing)
    - Using opposite stimulus
      - e.g. when seeing word *DOG* $\Rightarrow$ coded as sound (the word)
      - e.g. when hearing the word *DOG* $\Rightarrow$ visual code/picture of dog
- Semantic code
  - Abstract representations of meaning of stimulus
  - Important in long-term memory

Cont. Memory

2. Cont. Working Memory

- Capacity of Working Memory
  - Information maintained by rehearsal (i.e. paying attention to process)
  - Example:
    - Think of four letters (e.g. *J*, *T*, *N*, *L*)
    - Count backwards by $3s$ from 187
    - What happens? You forget letters after $15s$, why? No rehearsal*
  - When list of items in memory increases
    - This "decay" occurs faster
    - Due to greater gap $\Rightarrow$ delay in rehearsing each item
  - Imp. Q: what is max. # of items that can be held in working memory?
    - Miller, 1956: "magical number": 7 ± 2 (i.e. $5 - 9$) items/units
    - Made of "chunks" of familiar units (e.g. words), i.e. 7 ± 2 chunks
    - This increases capacity of working memory
    - Example:
      - *C.A.T.D.O.G.R.A.T.*: string of 9 items
      - But *CAT.DOG.RAT*: 3 chunks (within 7 ± 2 limit)

0 5 3 4 2 9 6 7 5 1

055 649 5378

Cont. Memory

2. Cont. Working Memory

- Cont. Capacity of Working Memory
  - Summary:
    - Don't present more than $5 - 9$ chunks of information to remember
    - Make chunks meaningful (e.g. 055)
    - Provide training on recalling chunked information

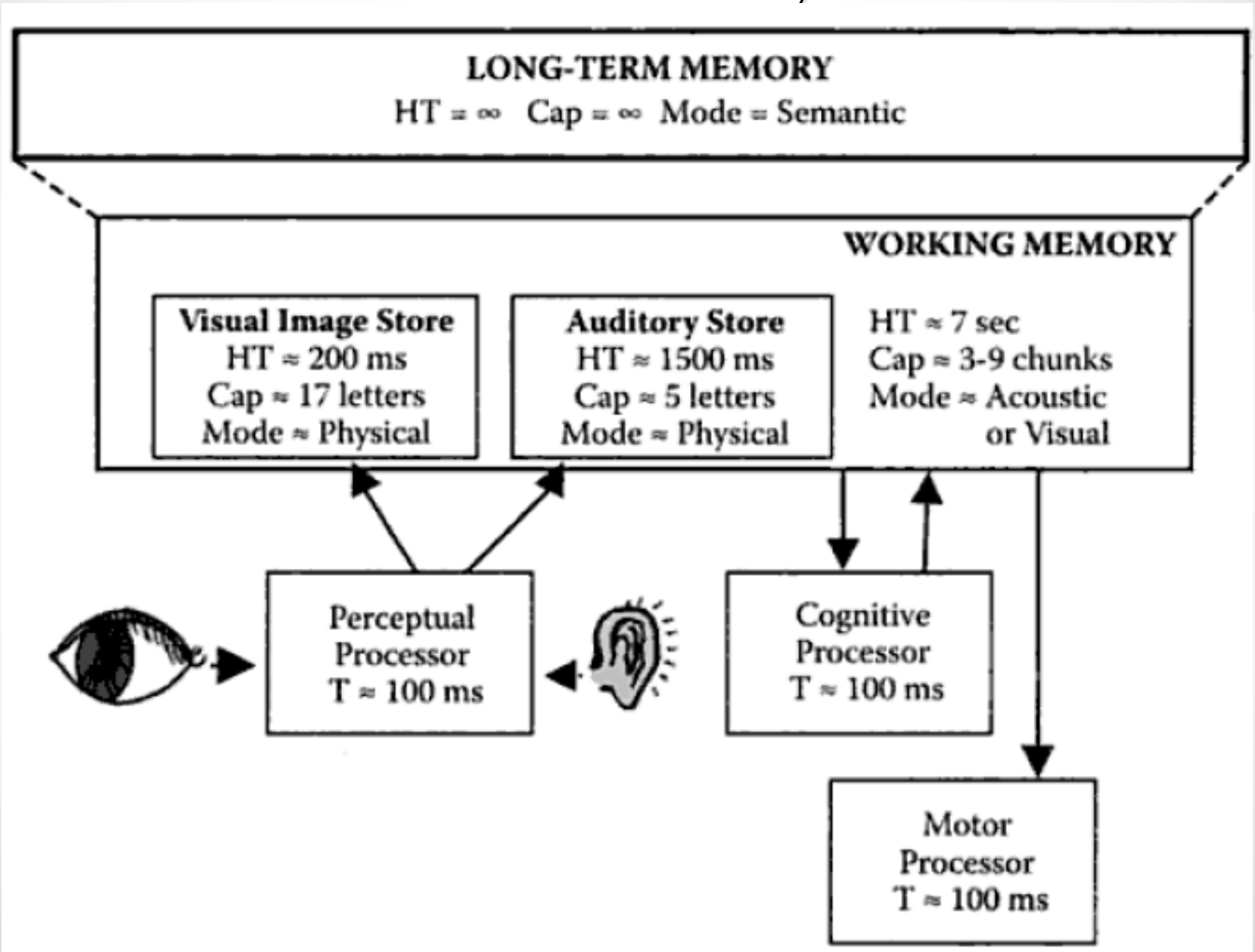
- Searching Working Memory
  - Time to search for item in WM list (e.g. names) ↑ as list items ↑ linearly
  - Time to search for item in WM per item of memory = $38\,ms$
  - All items are searched for equally

Cont. Memory

3. Long-term memory

- Transferring information from WM to LTM
  - Transferred by semantic coding
  - i.e. by adding meaning to information + linking to items already in LTM
  - e.g.: studying for exams:
    - If by repeating material ⇒ hard to recall info.
    - Effective method: semantically encode info.
- Ways to recall information from LTM
  - Analyze, compare, relate to past knowledge
  - Organizing info. at start
    ⇒ easier to transfer to LTM
    ⇒ more organized info. in LTM
    ⇒ easier to recall/retrieve info. from LTM
  - Using "mnemonics" to organize info.:
    - i.e. use first letter of item in a list and attach word/image to it
    - Makes info. retrieval faster

Cont. Memory


LONG-TERM MEMORY
HT = ∞ Cap = ∞ Mode = Semantic
WORKING MEMORY
Visual Image Store
HT ≈ 200 ms
Cap ≈ 17 letters
Mode ≈ Physical
Auditory Store
HT ≈ 1500 ms
Cap ≈ 5 letters
Mode ≈ Physical
HT ≈ 7 sec
Cap ≈ 3-9 chunks
Mode ≈ Acoustic
or Visual
Perceptual
Processor
T ≈ 100 ms
Cognitive
Processor
T ≈ 100 ms
Motor
Processor
T ≈ 100 ms

Attention

Attention

- Four types of attention tasks / situations
  1. Selective attention
  2. Focused attention
  3. Divided attention
  4. Sustained attention

Cont. Attention

1. Selective attention
   - Monitoring several sources of info. (aka channels) to perform a single task
   - E.g.: A pilot scanning the instruments
   - E.g.: player looking for opening in soccer field

- Improving selective attention
  - Use as few channels to be scanned for signals as possible
  - Tell user which channel is more important ⇒ more effective attention
  - Reduce level of stress on person ⇒ scan more channels
  - Show person where signal is more likely to show up
  - Train person on how to scan effectively
  - Visual channels: keep close together (to scan easier)
  - Auditory channels: make sure they don't mask each other

Cont. Attention

2. Focused attention
   - Attending one source of information and excluding other sources
   - e.g.: trying to read while someone is talking on the phone
   - e.g.: listening to a person talk in a crowded, noisy gathering

- Improving focused attention
  - Make competing channels as distinct as possible from channel of interest
  - Separate (in physical space) competing channels from channel of interest
  - Reduce number of competing channels
  - Make channel of interest (vs. competing channels)
    - Larger
    - Brighter
    - Louder, etc.

Cont. Attention

3. Divided attention
   - Paying attention to
     - Two (or more) sources of information,
     - Perform two (or more) tasks simultaneously (aka time-sharing)
   - E.g.: driving a car while talking to a passenger
     - Driving: visual input and manual response
     - Talking: auditory input and vocal responses
   - E.g.: eating dinner while watching evening news
   - Theories existing to explain performance in divided attention:
     - Single-resource theories: 1 source of resources, shared by all mental processes
     - Multiple-resource theories: multiple, independent resource pools

- Improving divided attention
  - Minimize as much as possible sources of information
  - Decrease as much as possible difficulty of tasks
  - Make tasks as different as possible in terms of input/output modes
  - Good way to divide attention: prioritize tasks relatively

Cont. Attention

4. Sustained attention (aka monitoring, vigilance)
   - Attention over long period of time to detect infrequently occurring signals
   - E.g.: security guards viewing TV monitors for the infrequent intruder
   - E.g.: air defense radar operator waiting to see missile
   - E.g.: inspector on assembly line looking for defect in endless line of products moving by
   - Vigilance decrement:
     - Decline in speed of signal detection with time for task
     - Decline in accuracy of detection with time for task
     - Occurs for first $20 - 35$ min of "vigil" (*see next slide*)

- Improving vigilance:
  - Scheduled rest breaks, task variation
  - Increase conspicuity of signal (e.g. make it larger, brighter, etc.)
  - Insert false signals to see how operator will respond
  - Motivation (i.e. show importance of task)
  - Stimulants (e.g. coffee)
  - Keep noise, temp., illumination, other environmental factors: optimum

Cont. Attention

Sustained attention (vigilance)