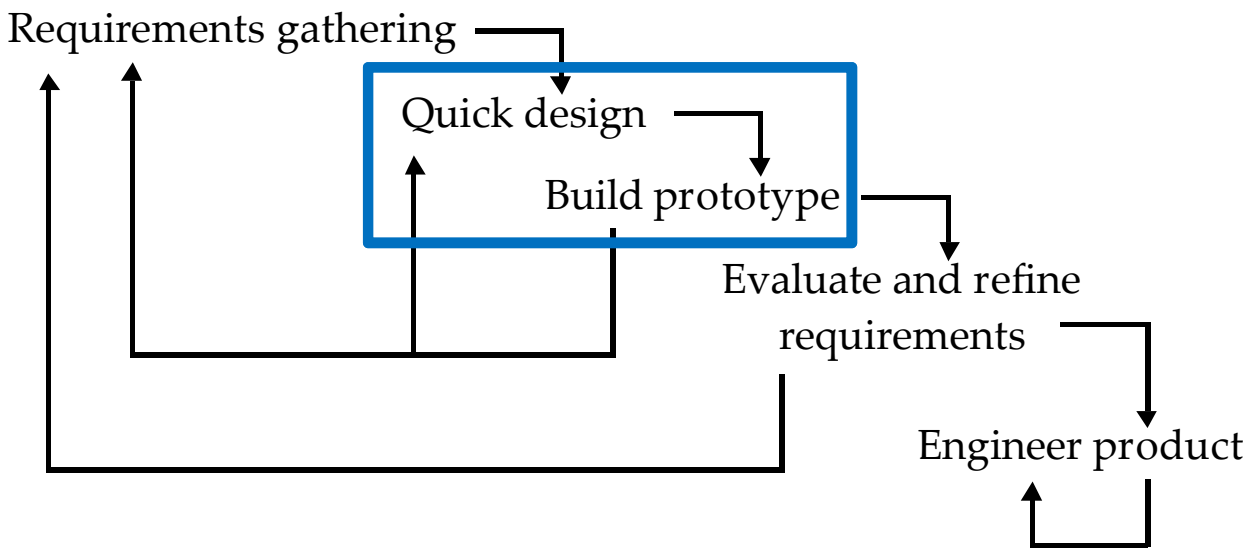
Interaction Design

Cognitive Aspects for Design

Interaction Design

- **Iterative** user centered design and development

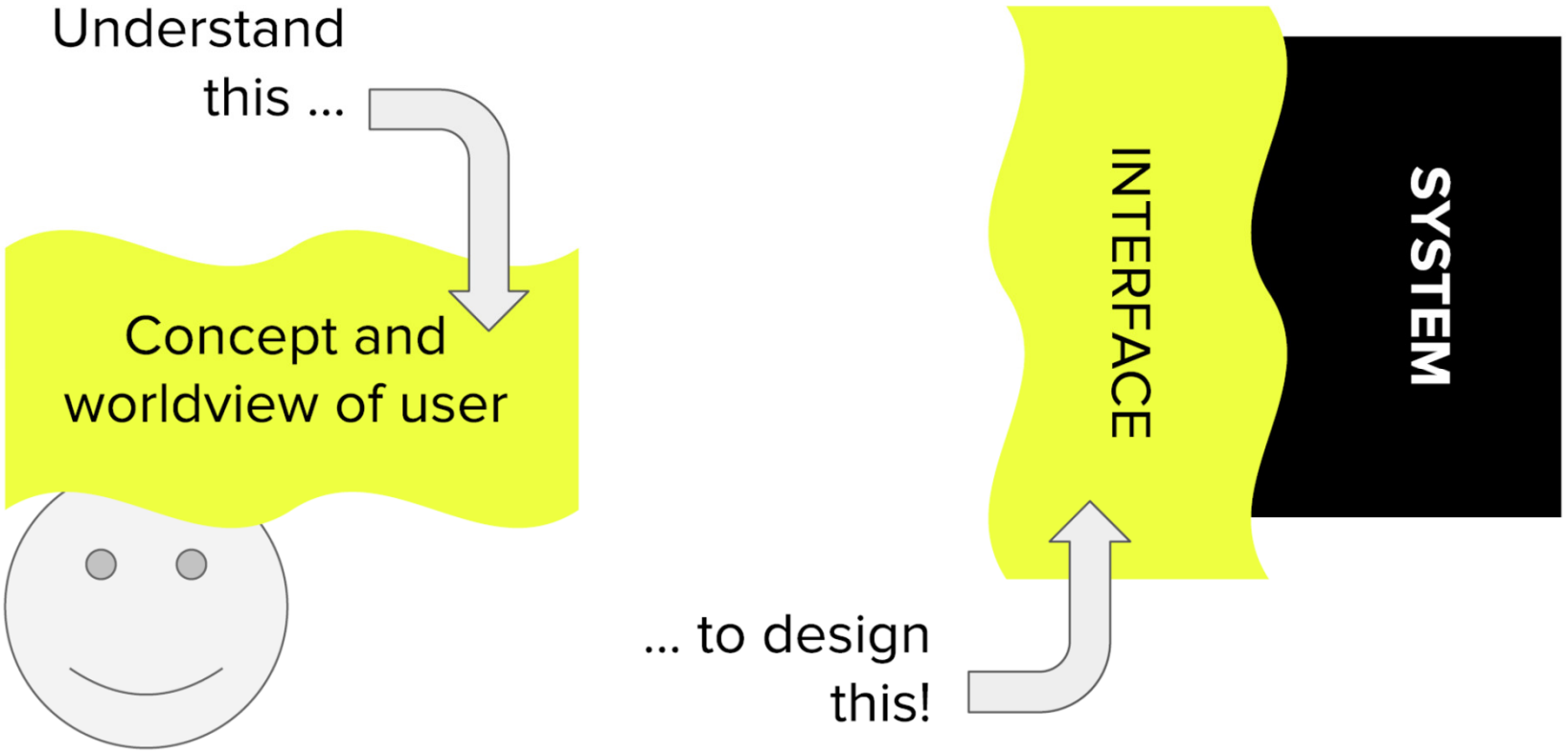


This Lecture

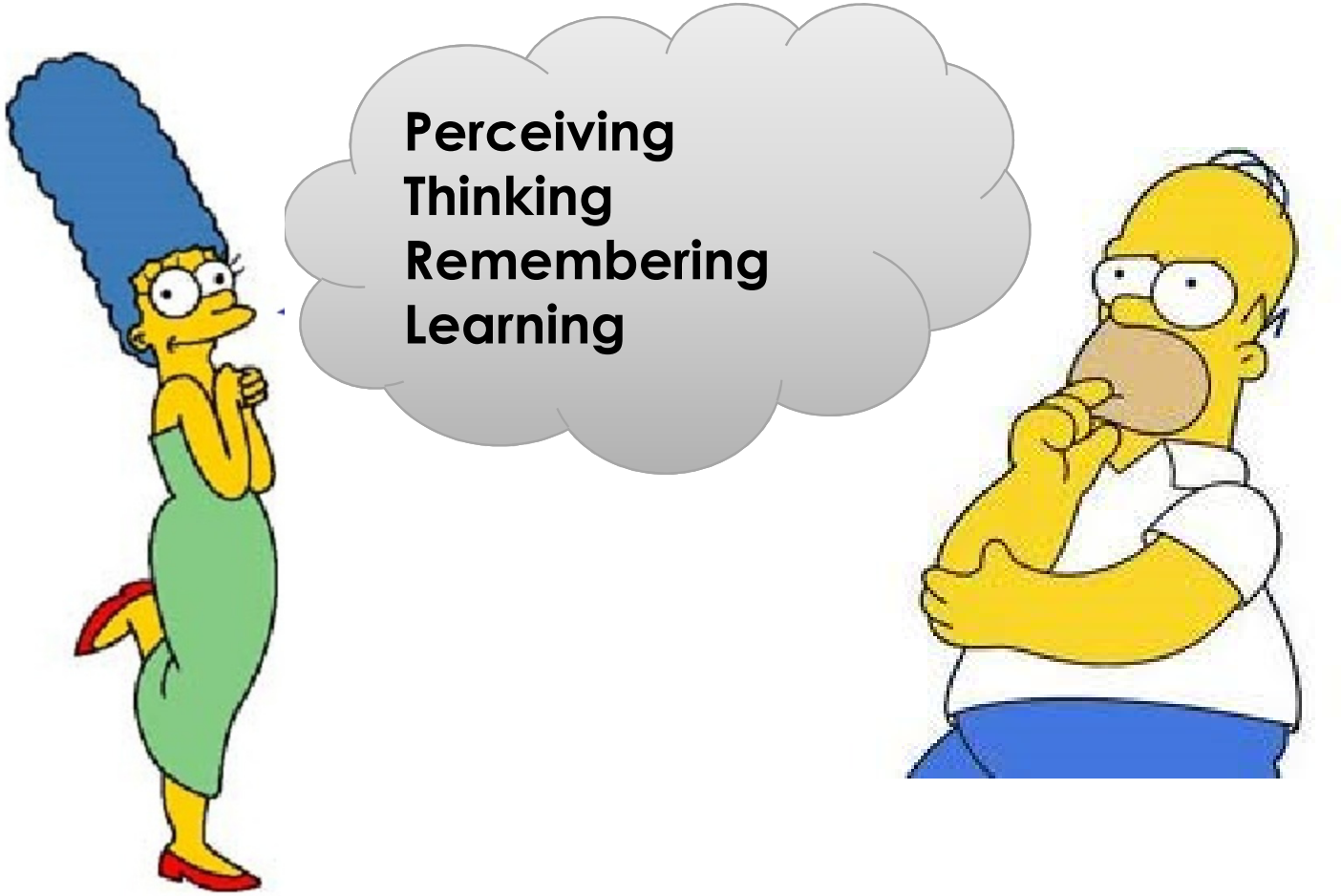
- Why we use cognitive psychology for interaction design?

- Five tools for understanding how people think
  1. The Model Human Processor
  2. Memory
  3. Gestalt psychology
  4. Human perception

Why Cognitive Psychology for Interaction Design?



What Goes on in the Mind of the User?



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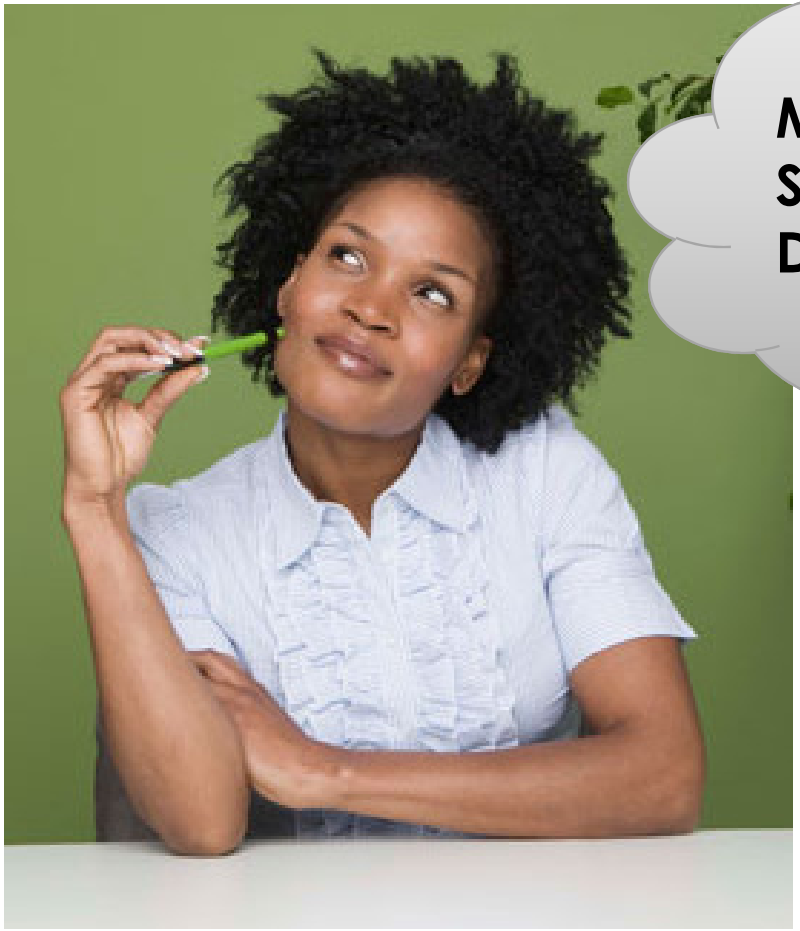
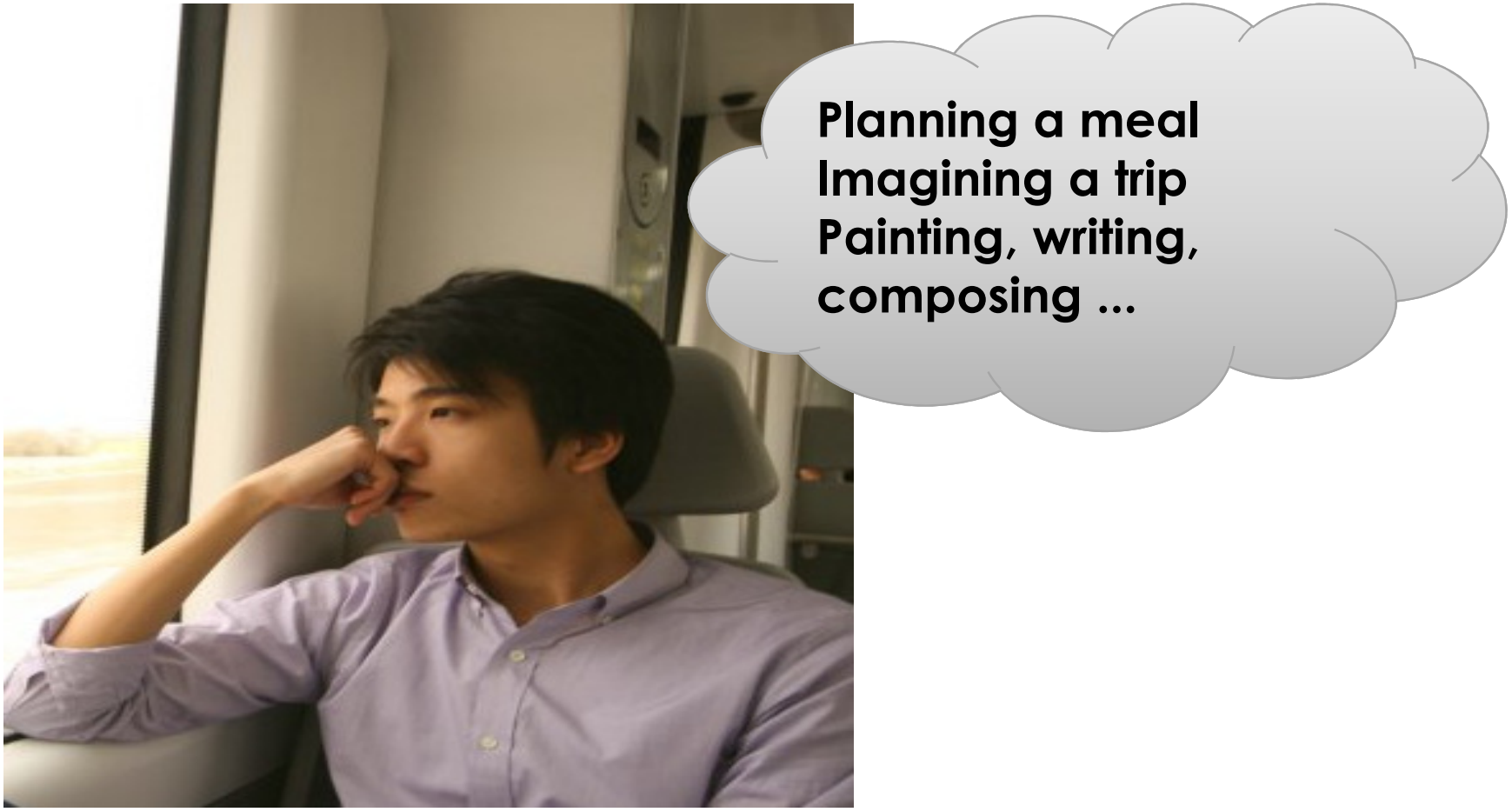


Making decisions
Solving problems
Daydreaming

What Goes on in the Mind of the User?



What Goes on in the Mind of the User?

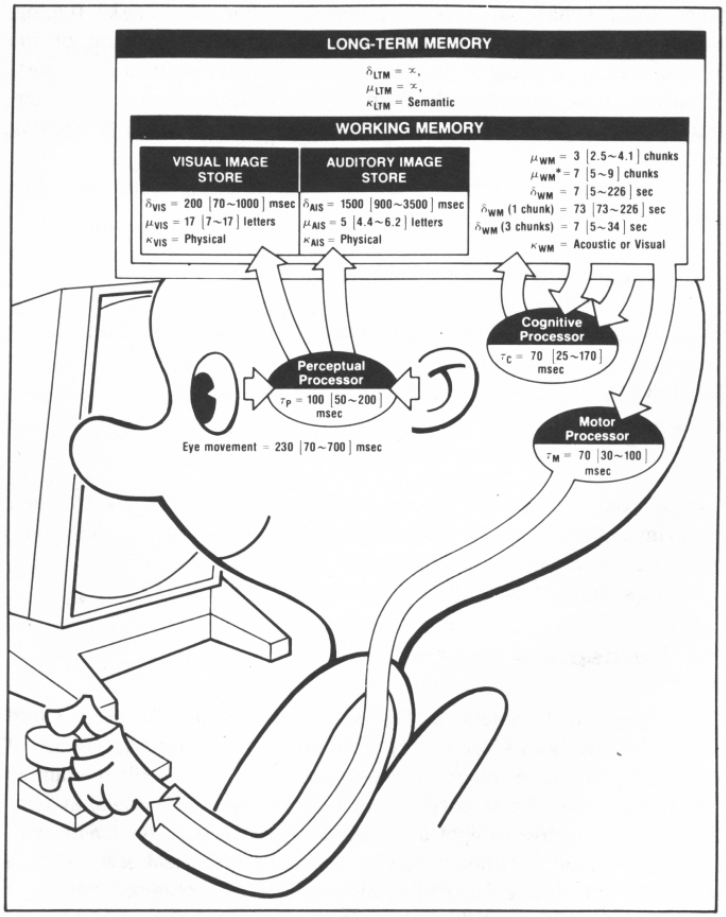
- There might be many users, but we can use **models** to understand how their minds generally tend to operate

Tools for Understanding Users

1. **The Model Human Processor**
2. Core aspects of cognition
3. Memory
4. Gestalt psychology
5. Human perception

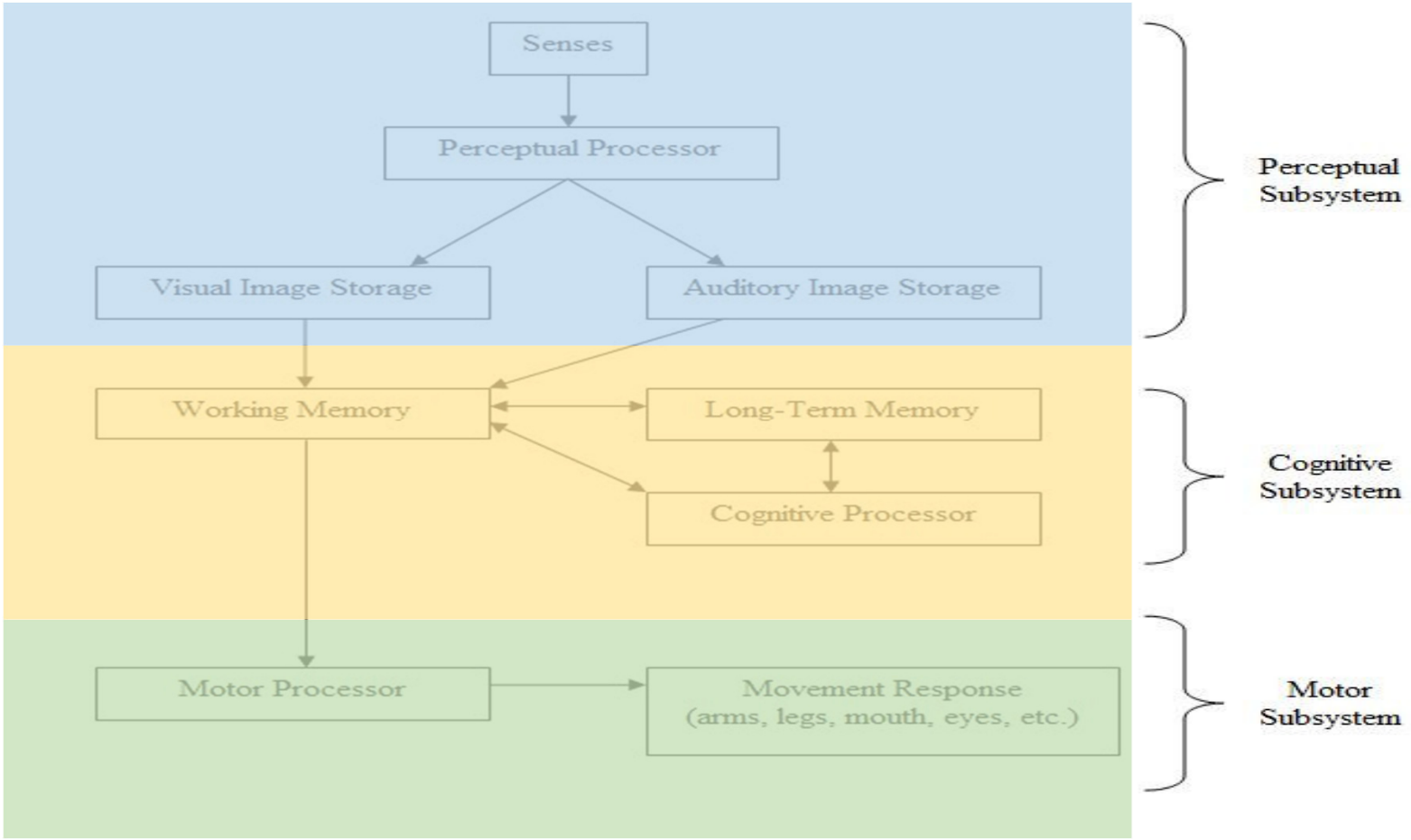
The Model Human Processor

- Three processors / subsystems
  - Perceptual
  - Cognitive
  - Motor

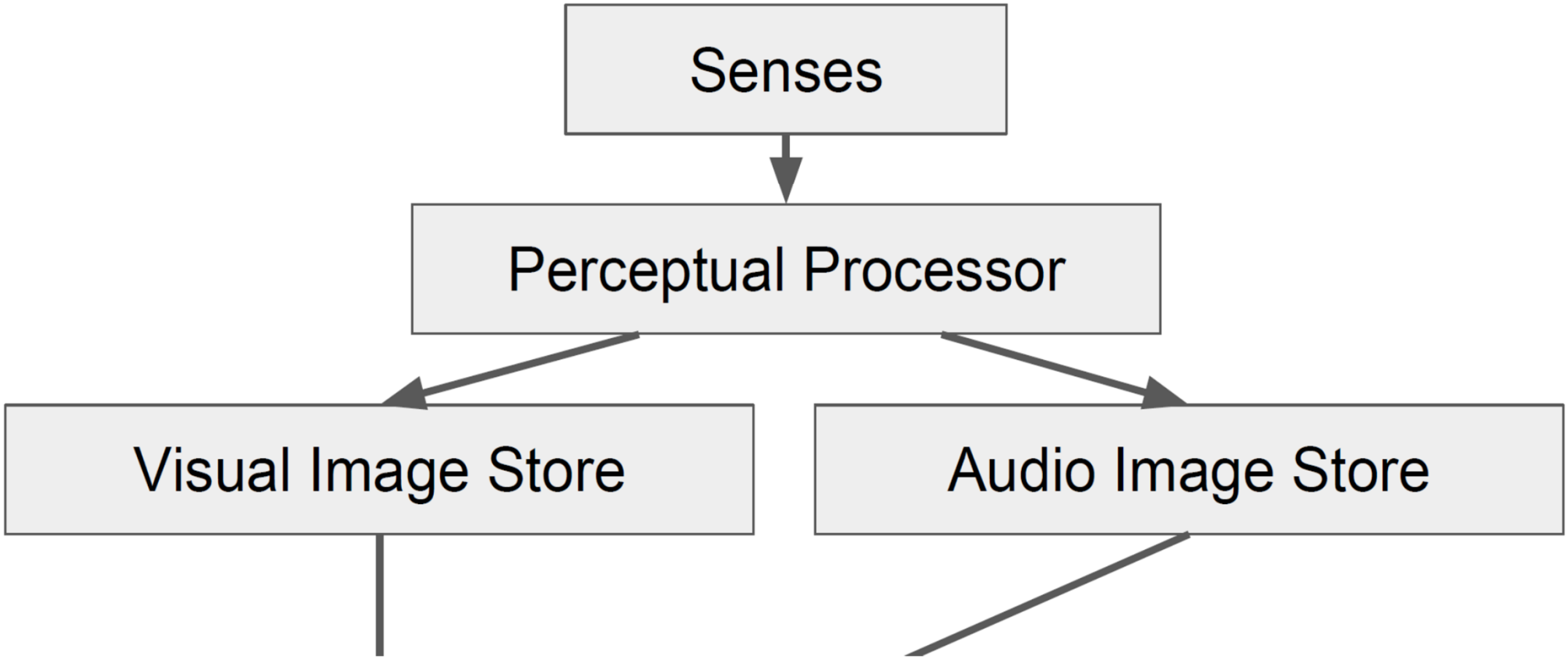


The model human processor (from Card, Moran and Newell, 1983)

The Model Human Processor

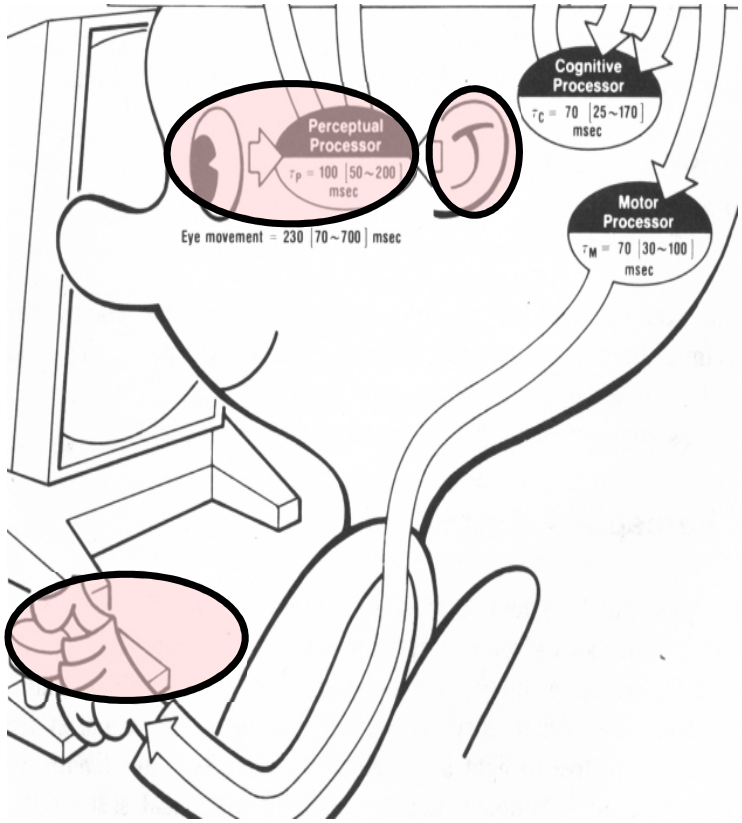


Perceptual Subsystem



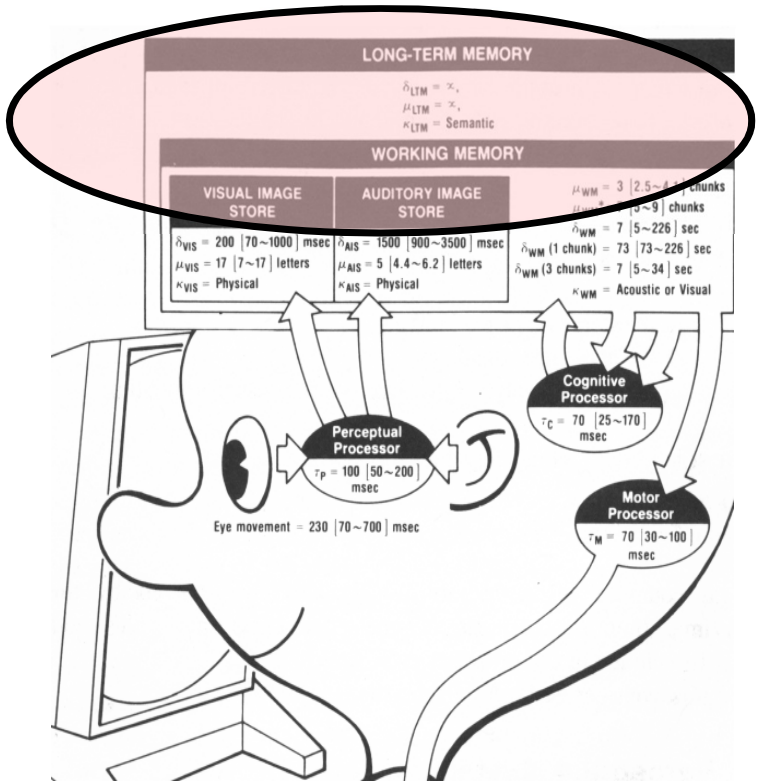
Perceptual Subsystem

- Information is received and responses given via a number of input channels
  - visual channel
  - auditory channel
  - haptic channel
  - smell …
  - taste …
- And output channels
  - movement

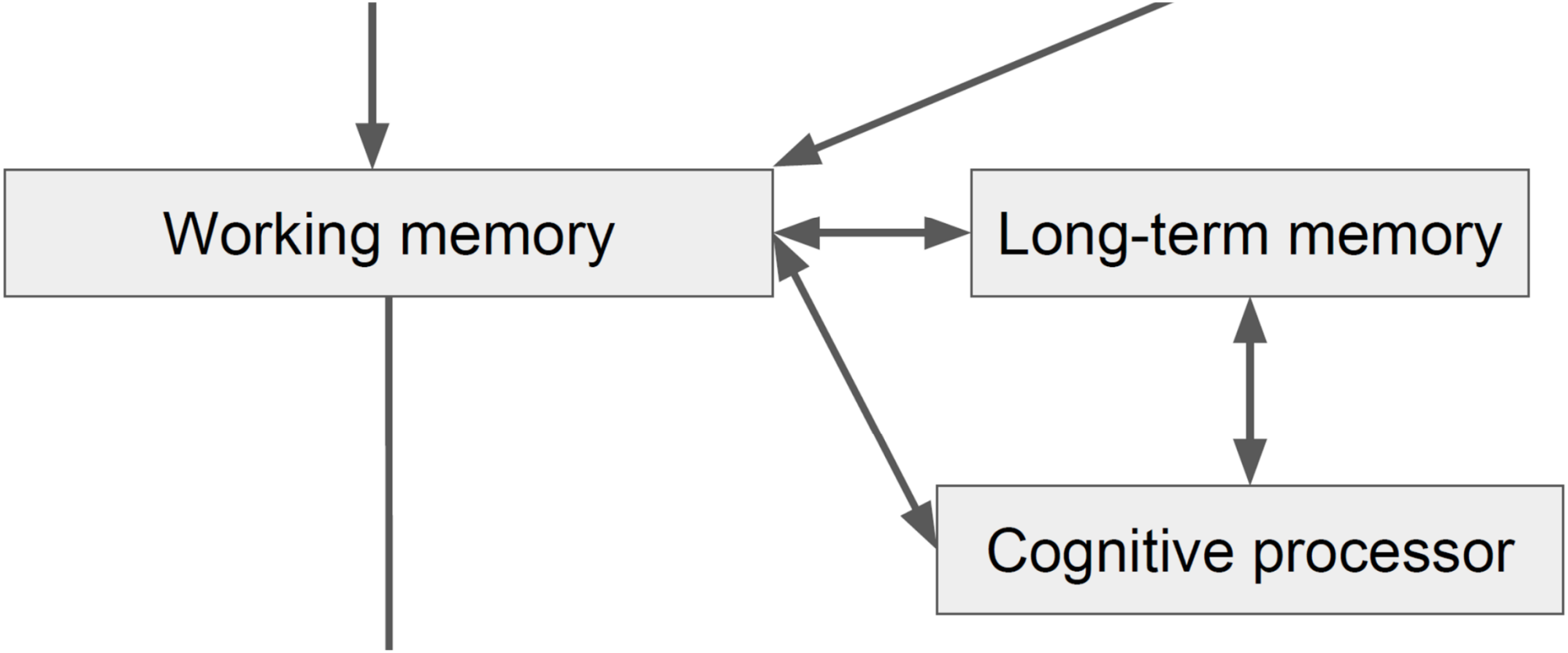


Perceptual Subsystem

- Information is stored in memory
  - sensory memory
  - working (short-term) memory
  - long-term memory

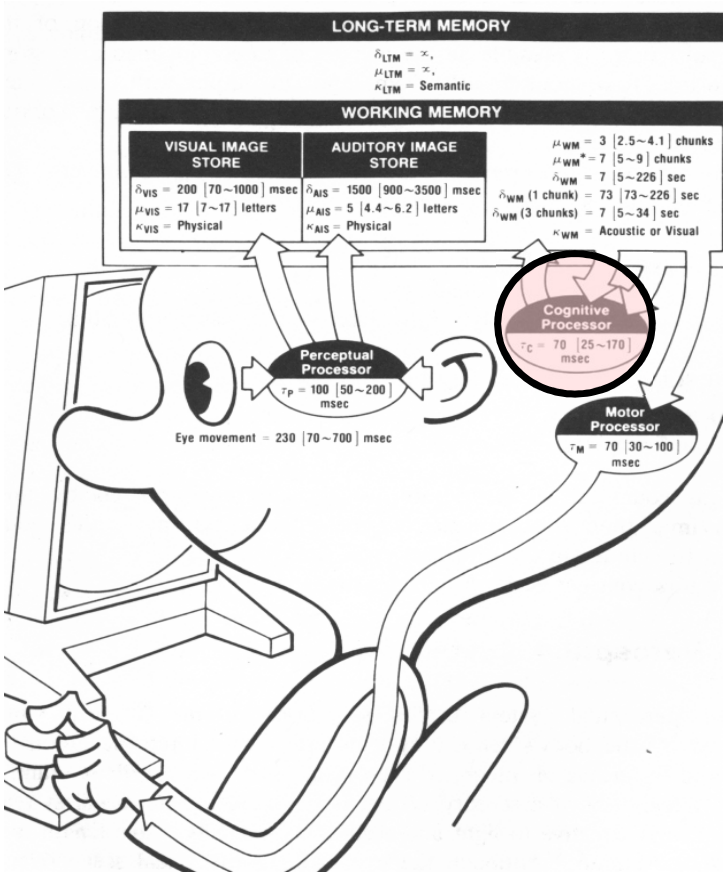


Cognitive Subsystem

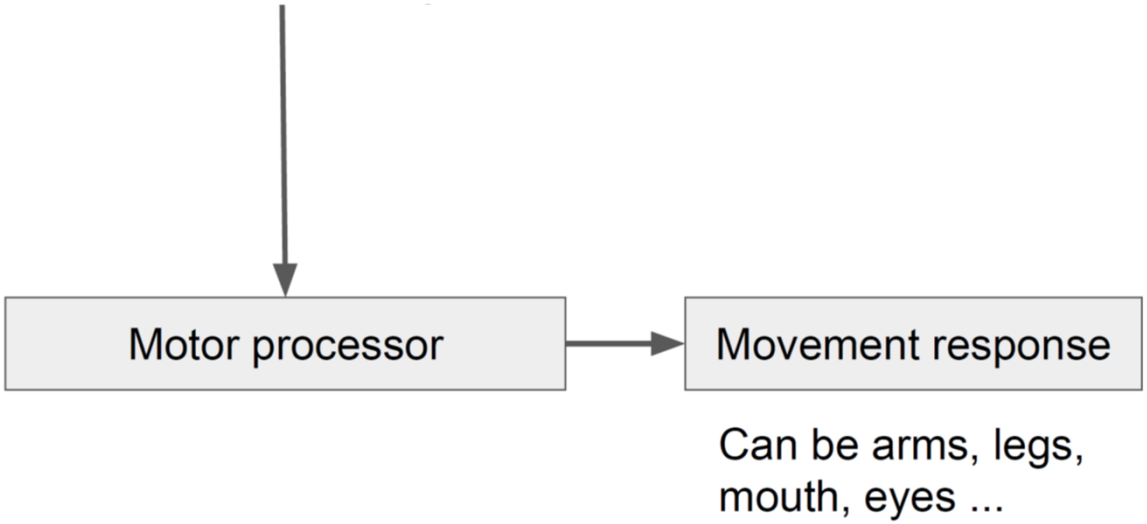


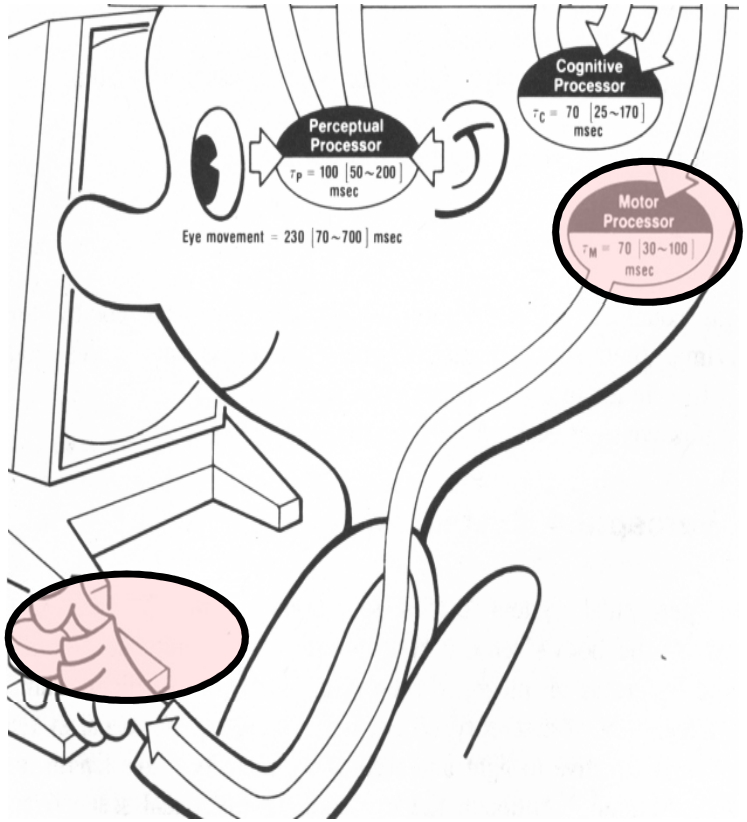
Cognitive Subsystem

- Information is processed and meaning applied
  - reasoning
  - problem-solving
  - skill acquisition
  - error feedback



Movement Subsystem





- A reaction is produced
  - using the motor skills (eyes, limbs, mouth, and so on) as a result of cognitive processing

Processor Cycle Time

- Each processor has a cycle time
  - Tp ~ 100ms [50-200 ms]
    - shorter for more intense stimuli
  - Tc ~ 70ms [25-170 ms]
  - Tm ~ 70ms [30-100 ms]
    - movement is not continuous, but consists of a sequence of discrete movements
      - sometimes preprogrammed talking, typing, etc.
- Allows a system designer to predict the time it takes a person to complete a task
  - by determining time of each operation

Tools for Understanding Users

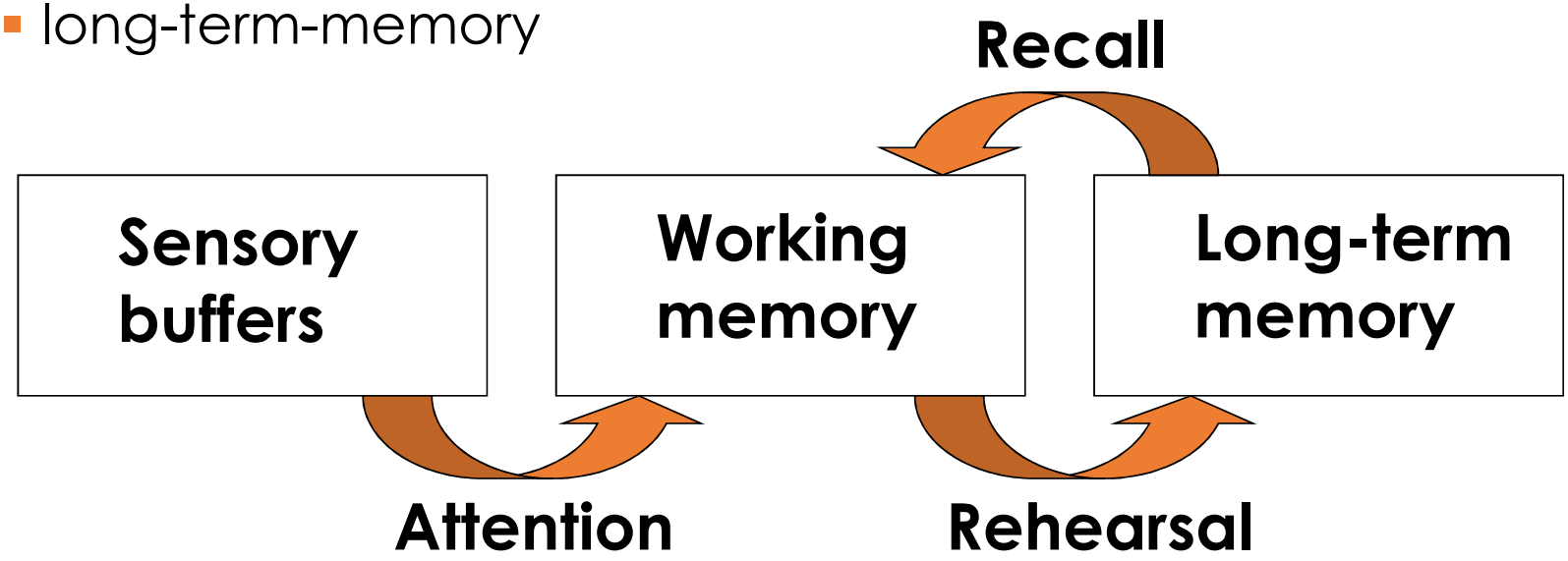
1. The Model Human Processor
2. **Core aspects of cognition**
3. **Memory**
4. Gestalt psychology
5. Human perception

Core Cognitive Aspects

- Perception and recognition
- Memory
- Reading, speaking and listening
- Problem-solving, planning, reasoning and decision-making, learning

Memory

- There are three types of memory:
  - sensory buffers
  - short-term memory
  - long-term-memory

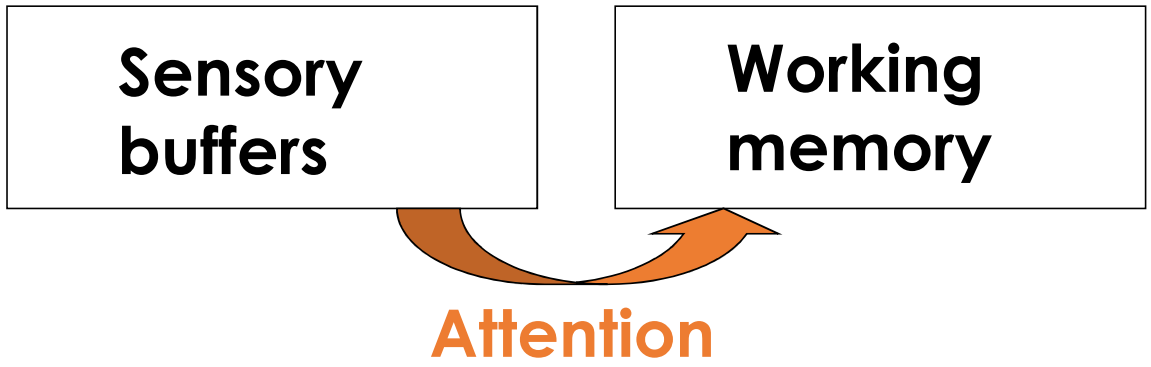


Sensory/Perceptual Memory

- The sensory memories act as buffers for stimuli received through the senses:
  - iconic memory for visual stimuli
  - echoic memory for aural stimuli
  - haptic memory for touch
- These memories are constantly overwritten by new information
  - E.g. information remains in iconic memory very briefly
    - In the order of 0.5 sec
- Information received by sensory memories is quickly passed into a more permanent memory store
  - Or overwritten and lost

The Role of Attention

- Information is passed from sensory memory into working memory by attention



- Attention is the **concentration of the "mind" on one** out of a number of competing stimuli or thoughts

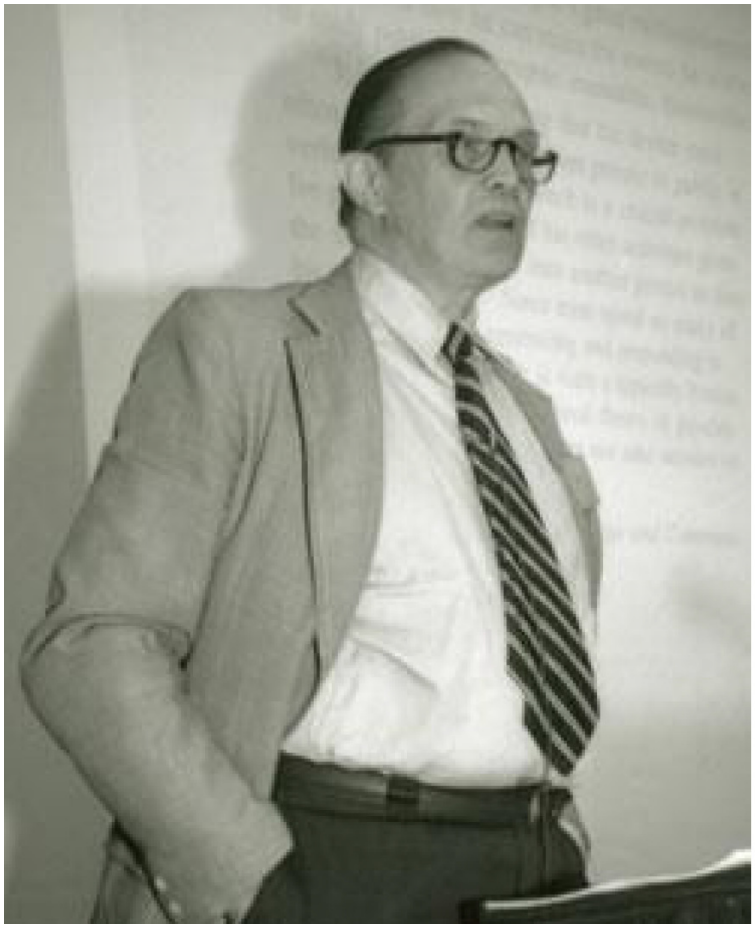
Sensory Memory: Design Implications

- You cannot assume that, because someone has seen or heard a particular message 5 seconds earlier, that person **will remember it**
- Either you must keep the message displayed until it is no longer needed (the best strategy)
  - or the user must be able to apply the information immediately
- As the information becomes the locus of attention, it moves into **working memory** where it will persist for as long as **10 seconds**

Short-term Memory (STM)

- Working memory can be accessed rapidly
  - In the order of 70 ms
- It is transient in nature
- It has a limited capacity of 7 +/- 2 chunks of information
- Information is subject to interference
- Items are lost from memory if not rehearsed

Short-term Memory (STM)



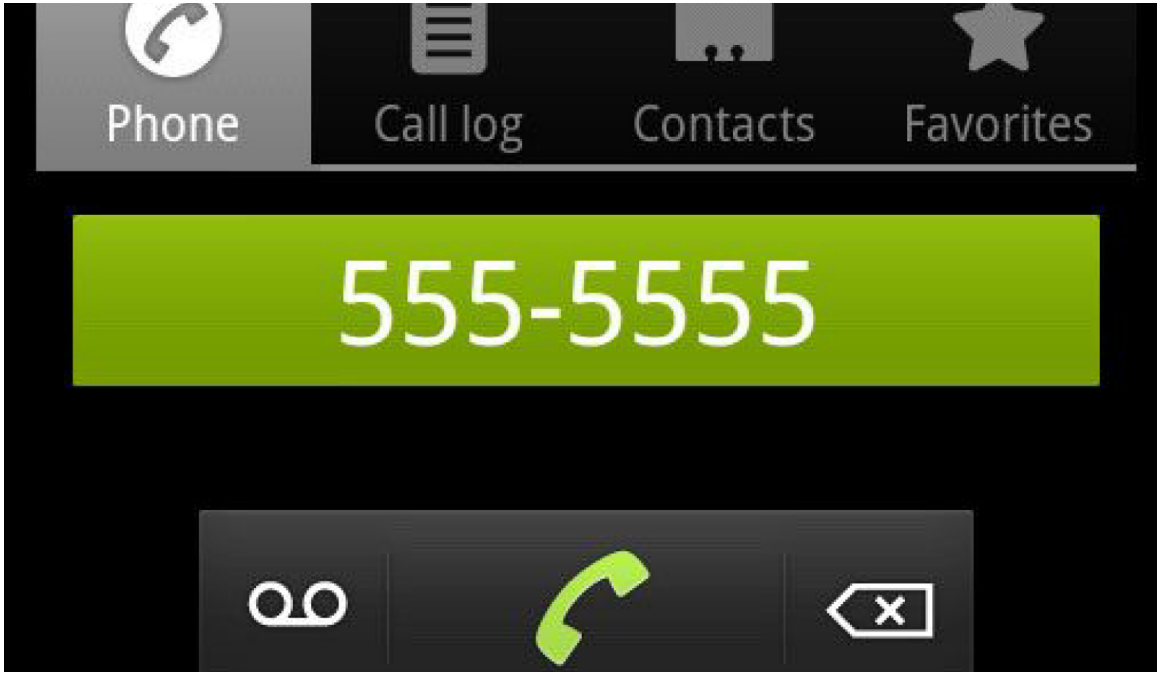
“The rule of 7, plus or minus two.”

George Miller, 1956

Grouping / Chunking

- A strategy of grouping items into **smaller chunks** of seven, plus or minus two chunks
  - 2125685382 vs. 212DanHome
    - 10 chunks vs. 3 (assuming 212 is familiar)
- Short-term memory is constrained by number of chunks, not basic elements (e.g. digits)
- Patterns can be useful as aids to memory

Chunking : Example (1)



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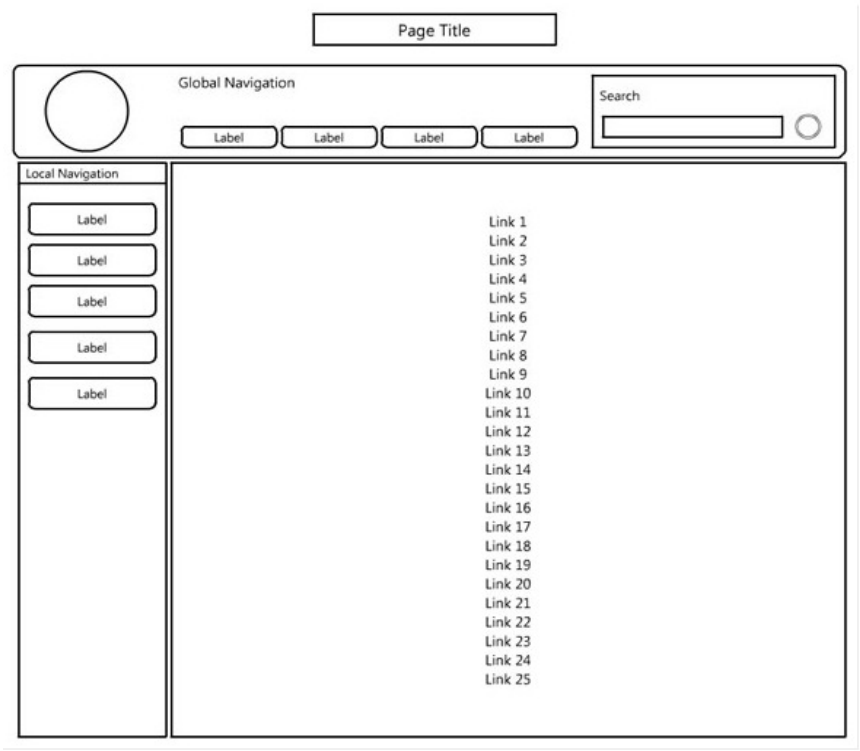
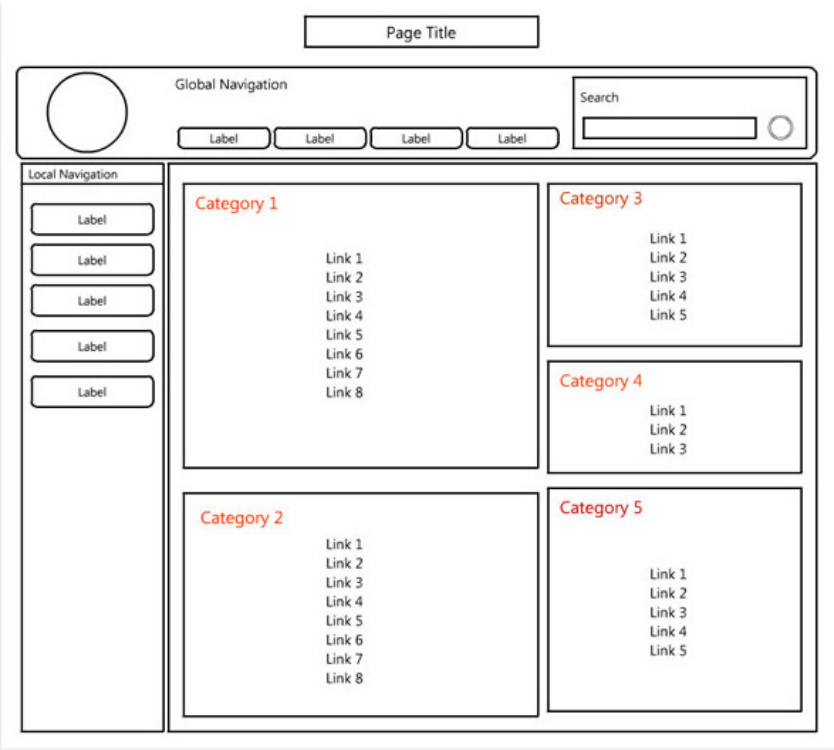
Fax: +44 207 581 8024

SW7 2AZ

SW14 8SN

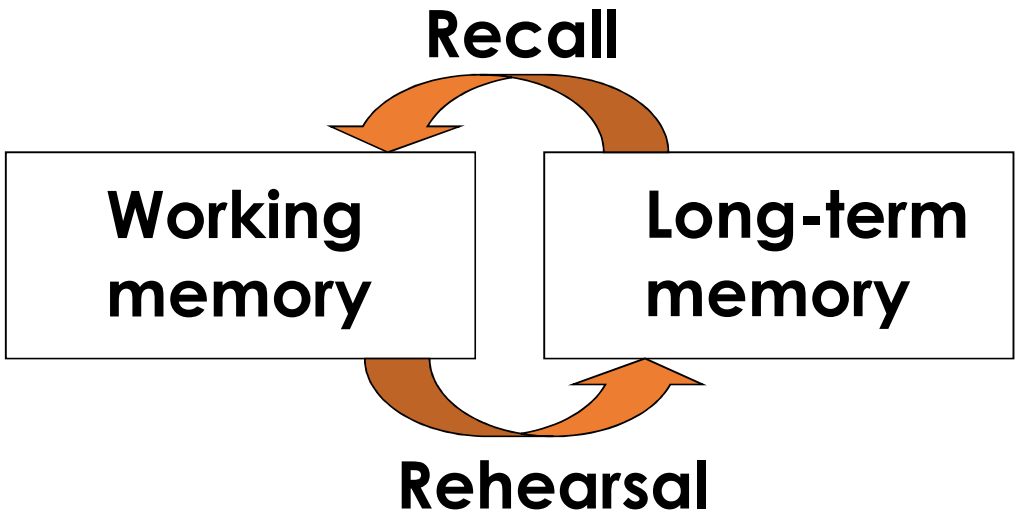
Chunking : Example (2)





Long-term Memory (LTM)

- People store meaning or knowledge in long-term memory
  - When people are **recalling** units of meaningful information they are placing items from long-term memory in an **active state** (working memory)



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
  - makes information easier to remember

Forgetting

- Decay
  - information is lost gradually but very slowly
- Interference
  - new information replaces old
  - old may interfere with new
- Memory is selective

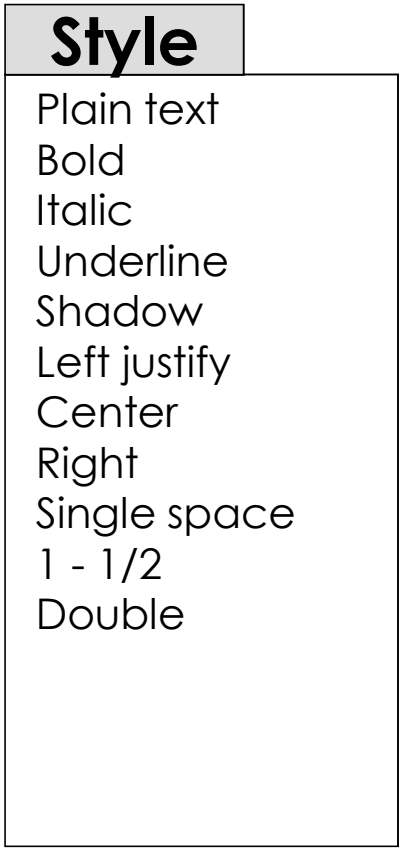
  … affected by emotion – can subconsciously **choose to** forget

Retrieval

- Recall
  - when you remember something
    - e.g. login and password
- Recognition
  - occurs when you are **presented** with the item you are trying to remember
    - e.g. when you list all the files in your directory to help you remember

Example

- Question
  - Can you improve the design of this menu to relieve the load on user's memory?
- Focus on:
  - Recognition vs. Recall



LTM: Implications for Design

Context

- Context plays a major role in what people see and hear

Mind set

- Factors that we know and bring to a situation can have a profound effect on the usability of an interface

LTM: Implications for Design

Grouping

- If you do not try to add grouping into the interface…
  - the user's perceptual processes will still try to impose a structure on the display
  - and it might not be the structure you want!

Tools for Understanding Users

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Gestalt Theory

- "Gestalt" in psychology implies the idea of **perception in context**

- Gestalt theory describes how the mind organizes visual data
  - We do not see things in isolation but as **parts of a whole**

The Gestalt Laws

- The Gestalt laws of perceptual organisation

1. **Figure-ground relationship:** we group elements as either figures or ground
2. **Proximity:** we group by distance or location
3. **Similarity:** we group by type
4. **Symmetry:** we group by meaning
5. **Continuity:** we group by flow (alignment)
6. **Closure:** we perceive shapes that are not (completely) there

1. Figure-ground Relationship

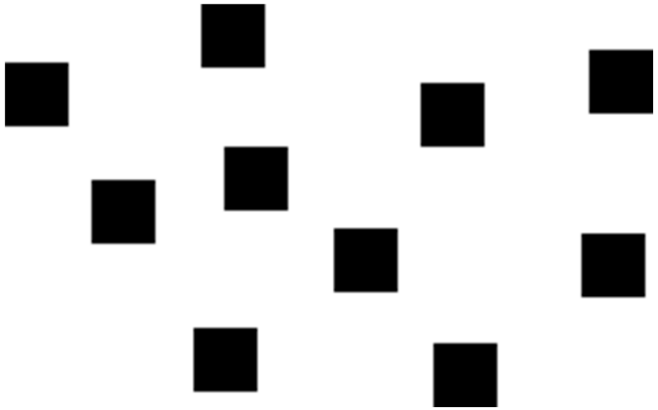
- Images are partitioned into
  - Figure (foreground)
  - Ground (background)

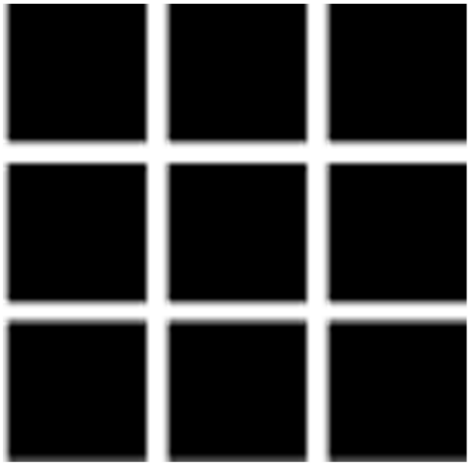
1. Figure-ground Relationship

- Figure/ground contrast affects legibility

2. Proximity

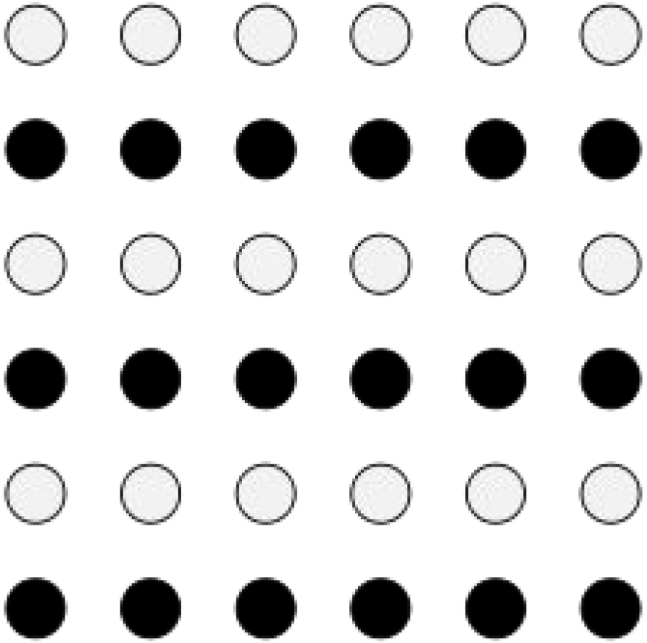
- We group by distance or location

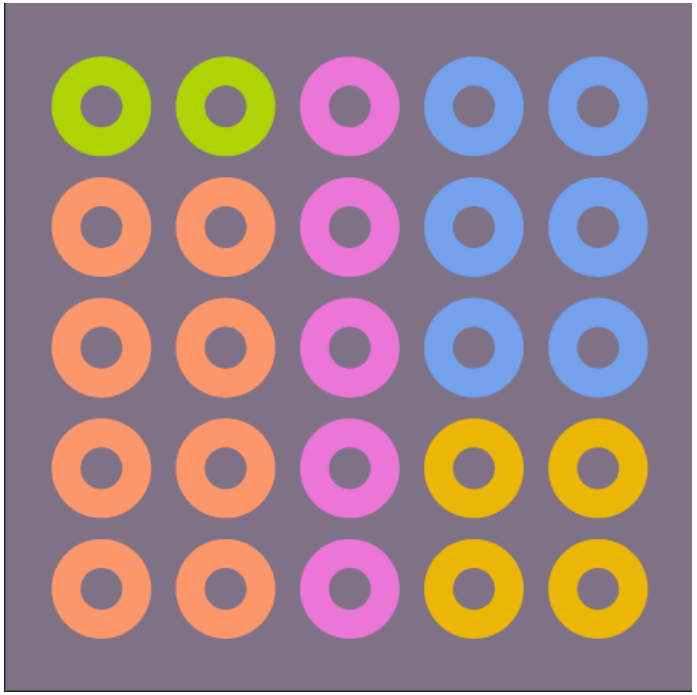




3. Similarity

- We group by type



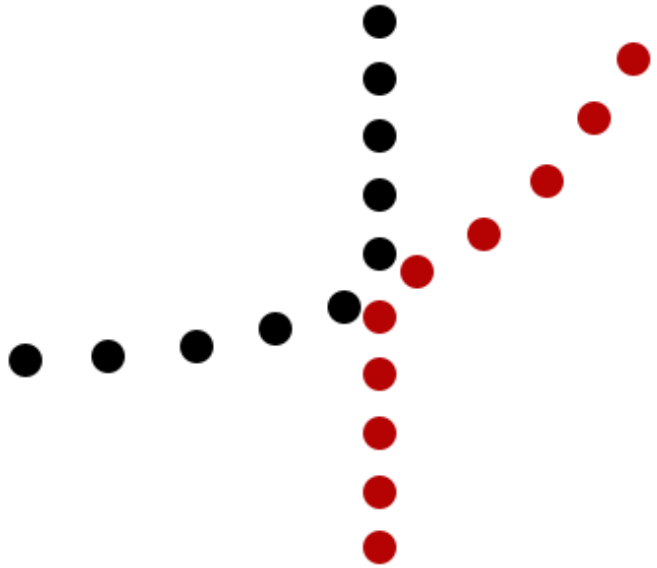


4. Symmetry

- We group by meaning

5. Continuity

- We group by flow or alignment



6. Closure

- We perceive objects as being whole when they are not complete

Tools for Understanding Users

1. The Model Human Processor
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5. **Visual perception**

Visual Perception

- Visual perception is **active**
  - blends sensation and knowledge
    - the active process of selecting, organizing, and interpreting the information brought to the brain by the senses
  - Selective **attention** & Perceptual **expectancy**

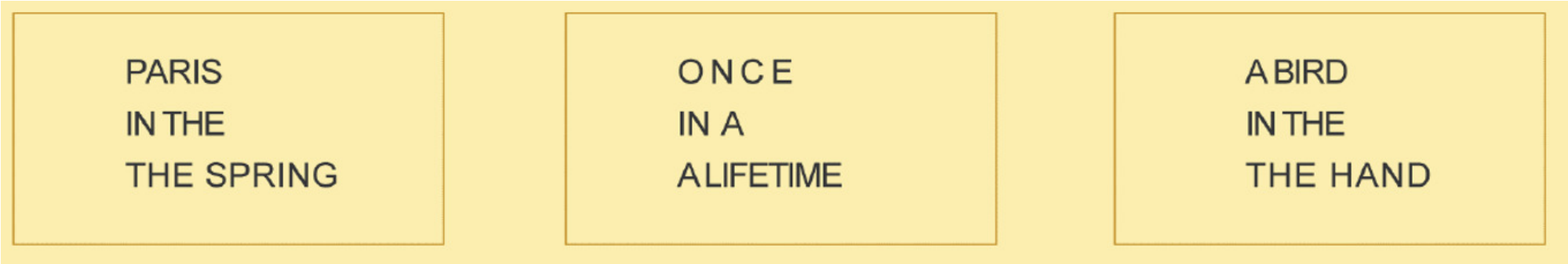
Visual Perception : Reading

- There are several stages in the reading process:
  1. The **visual pattern of the word** is perceived
  2. It is then decoded with reference to an internal representation of language
  3. The final stages of language processing include syntactic and semantic analysis and operate on phrases or sentences

Removing the word shape clues (e.g. by capitalizing words) is detrimental to reading speed and accuracy

Visual Perception: Expectation

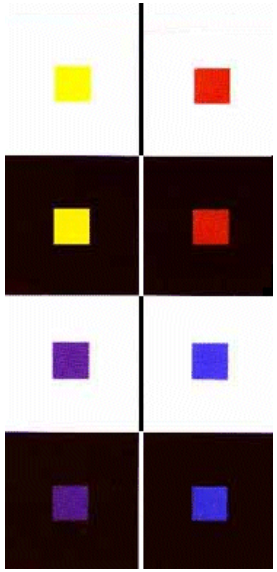
- What we expect to see affects what we perceive reality to be

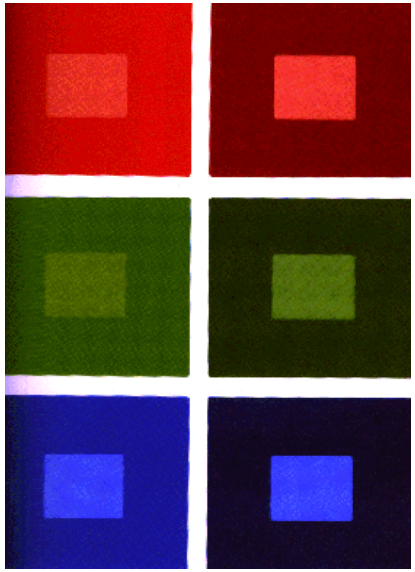


Source: after Bruner and Postman, 1949, pp. 206 – 23.

Visual Perception: Colour

- **Context** is crucial
  - Perception of colour is determined by the **physical context** of the object
    - number, size, proximity and energy characteristics of other objects in the field of view

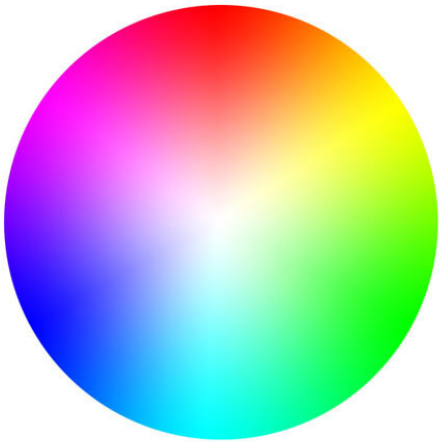




The RGB Colour Wheel

- A colour wheel is a representation of colour
  - there are different ways to express colour relationships

- In the RGB colour wheel, the primary colours are red, green, and blue



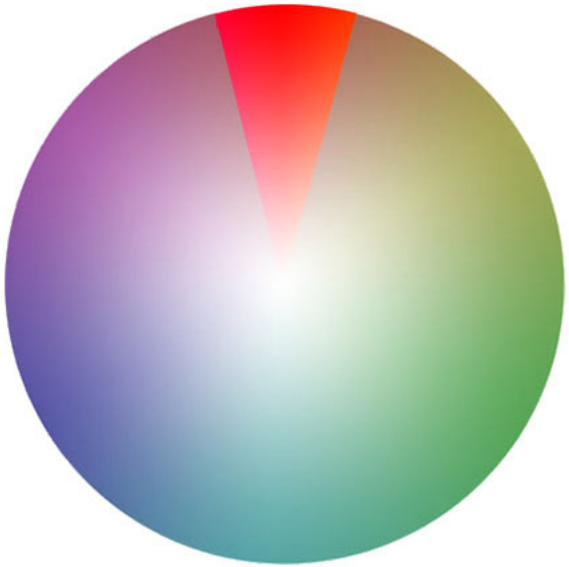
Colour Schemes

- The different colour schemes are different combinations of colours based on their relationship to each other
  - Monochromatic
  - Analogous
  - Complementary
  - Triadic

- Any design should have a colour scheme
  - used consistently throughout

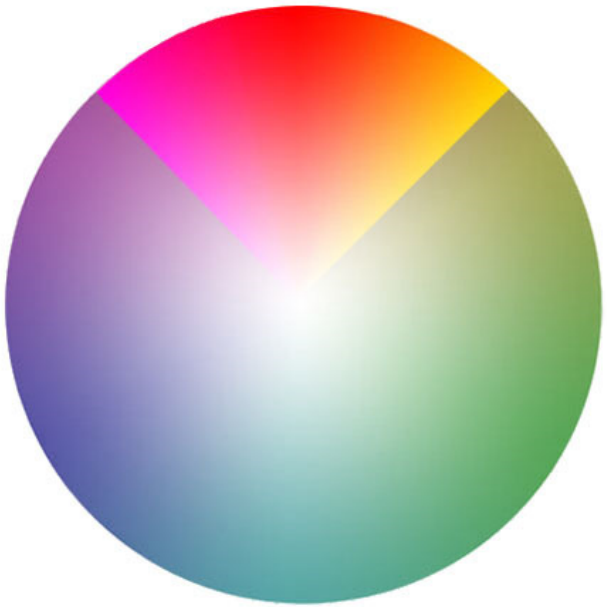
Monochromatic Colour Scheme

- Based on different tones of the **same** colour



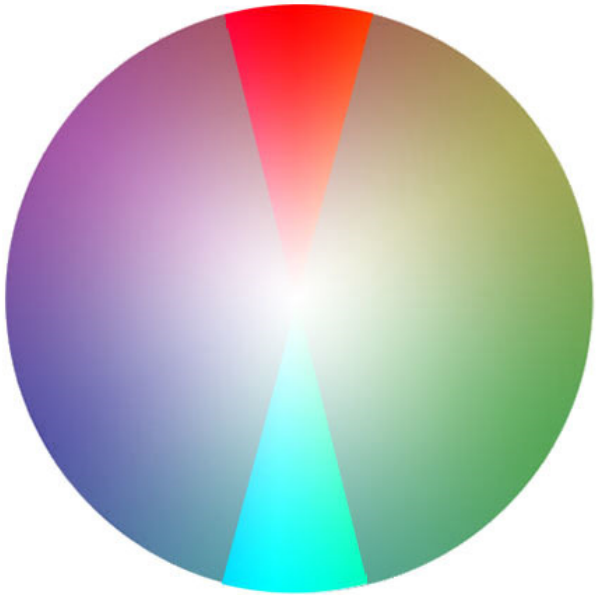
Analogous Colour Scheme

- Based on colours that are **adjacent** to each other on the colour wheel



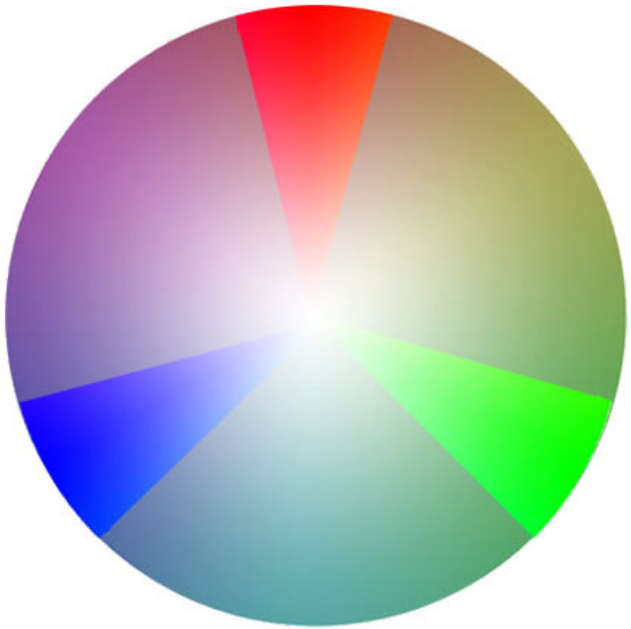
Complementary Colour Scheme

- Based on colours that are **complementary** to each other on the colour wheel



Triadic Colour Scheme

- Based on three colours **equally spaced** around the colour wheel



Colour: Implication for Task 3

- Google "**colour scheme picker**"
  - Loads of options
  - You will learn a lot about using colour
  - Examples:
    - http://www.colorexplorer.com/
    - http://www.colorpicker.com/
    - http://paletton.com/#uid=13y0u0kllllaFw0g0qFqFg0w0aF
    - https://color.adobe.com/

Summary

1. Users see what they expect to see
   - be consistent
   - exploit prior knowledge

2. Users have difficulty focussing on more than one activity at a time
   - group things together that go together
   - give prominence to important items

Summary

3. Structured layouts are easier to perceive

Use Gestalt Laws of:

- figure ground relationship
- proximity
- similarity
- symmetry
- closure
- continuity

Summary

4. It is easier to recognise than to recall

- put the knowledge that the user needs **in the user interface**
- rather than forcing her/him to rely on knowledge in the head

Study Material & Reading

- BOOK: Preece, J., Rogers, Y. and Sharp, H. Interaction Design.
  - Chapter: Cognitive Aspects