SIM 18/19 – T1.2
Limitations of the human perceptual system

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Acknowledgements: Most of this course is based on the excellent course offered by Prof. Kellogg Booth at the British Columbia University, Vancouver, Canada. Please acknowledge the original source when reusing these slides for academic purposes.

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Summary

- Human abilities
- The *Model Human Processor* (MHP)
- Memory

Topic: Human abilities

- Human abilities
- The *Model Human Processor* (MHP)
- Memory

Limitations of the perceptual system

Our initial perception has many limitations

- conveyance of info from perceptual to cognitive centers is constricted
- attention and external factors are central to what we finally “perceive”

-> our “mental image” of a scene, object or situation is a **constructed model**

- *periodically updated with isolated, incomplete and directed observations.*

-> ignoring roles of **perception and attention can** cause problems during interface design and testing.

Change blindness

- In the following examples
  - Image will blink or flicker
  - Image changes with each blink

Challenge: *Raise your hand as soon as you identify change*

Change blindness examples

- Ten demos of change blindness at the University of British Columbia (requires Quicktime)
- Examples from **Laboratoire Psychologie de la Perception**, Paris, France.
  - http://nivea.psycho.univ-paris5.fr/ECS/bagchangeNoflick.gif
  - http://nivea.psycho.univ-paris5.fr/ECS/kayakflick.gif

Change Blindness Example

- Experimental Psychology - Change Blindness:

http://www.youtube.com/watch%3Fv%3D38XO7ac9eSs

Vision systems: Like a camera?

Seems like it:

- *camera: keep steady, adjust focal lens length*
- *eye: focal point always moving, yet we perceive the world* as being sharp and in focus.

But how does it really work?

- *camera: film is exposed all at once by light from scene*
- *eye: electrical signals travel to nucleus, and **gradually** +* **selectively updates a mental image of a scene**

→ Camera is a poor metaphor for vision!

Vision is really more like touch:

- Imagine creating a mental model of a room's layout & furnishings by touching it when blindfolded or in the dark
- Model is built up serially (over time); process speeded if we start with a memory of what was in the room last time we were there,
- But if the memory is inaccurate or does not reflect current state, may take us longer to find the changes
- *because* ***we believe in an incorrect model.***

S-R (stimulus-response) compatibility

S-R: Connecting perception to action.

Task difficulty determined in part by:

- the particular sets of stimuli and response used, or
- **the way in which individual stimuli and responses are paired with each other**

Example (spatial pairing):

- If stimulus received on right side of body, easier to respond with right hand

Another S-R response example

- Name the **color of the text**
- Respond as quickly as possible
- Measure response time
- 3 trials

Verde

Branco

Amarelo

Vermelho

Preto

Azul

Simple experiment …

- Do it again!

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Perceptual fusion

- stimuli that occur within one perceptual processing (PP) cycle fuse into a single percept:
  - frame rate necessary for movies to look real?
    - time for 1 frame must be < Tp (100 msec)

      -> at least 10 frame/sec (better to double)

- practical examples:
  - lip synch on an old movie (not a frame rate issue!)
  - press button on a touchscreen: audio click comes late

Perceptual causality

- Two distinct stimuli can fuse
  - if the first event appears to *cause the other*
- Events must still occur in the same perceptual cycle

lip synch: is the voice really coming from that person?

touchscreen button: did my touch really make that click?

Pause:
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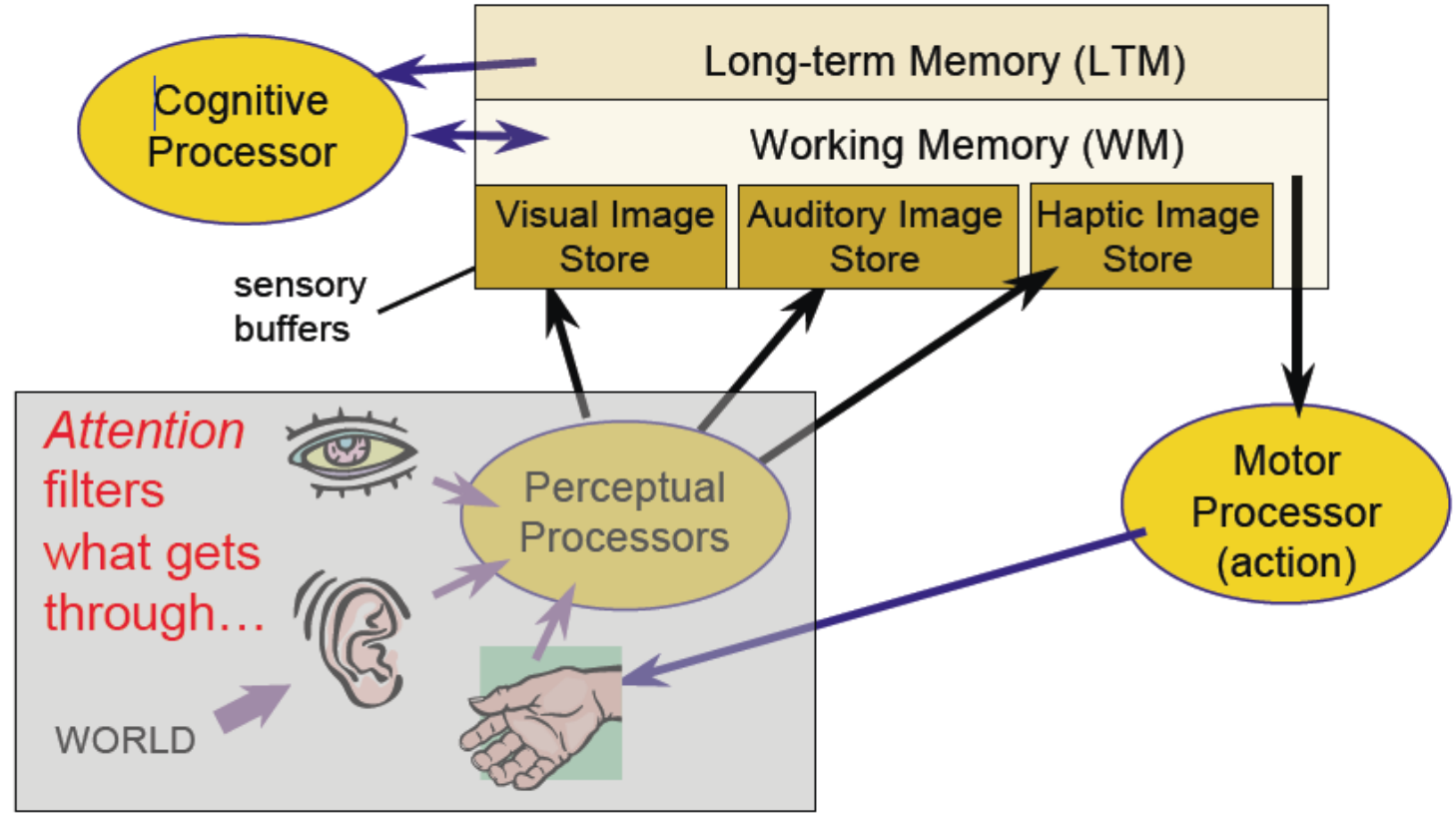
A model of human info processing

Elements:

1. Perception: *a few examples to persuade you that UI designers need to know lots about it*
2. Attention: *the gateway to memory*
3. Memory

- More implications for UI design
  - chunking
  - selection/action
  - (+ many, many more that we won't talk about)

Model Human Processor (MHP)



"The Psychology of Human-Computer Interaction", 1983 Card, Moran, & Newell

Attention: the ‘gateway to memory’

Filter in brain

- focus on certain things
- ignore the rest

3 types

- **selective: *choose one thing to focus on (endogenous control)***
- **divided: focus on more than 1 thing at once**
- **captured: attention is ‘demanded’ *externally (exogenous)***

which situation(s) describes your design context???
use the simplest model that works!

Selective attention

- Pick one thing to focus on, amongst many possibilities
  - eye movement to item of interest
  - head movement to sounds of interest
- Cocktail party effect
  - ability to “tune out” numerous conversations in same vicinity and focus on just one
- Single “locus of attention”

Divided attention

Do multiple tasks

– either “simultaneous” or time multiplexed (rapidly alternate)

Can degrade performance

– if combined tasks exceed human abilities

Interference between tasks

Summing up

- Cognitive processing is **modular:**
  - add up processing times
- Perception, audition, motor control = **system I/O**
  - each has associated memory
- Cognition = **CPU**
  - includes multi-level main memory
- Attention is **limited and regulates sensory input**
- Human sensorimotor abilities are deeply flawed
- Design needs to accommodate human diversity

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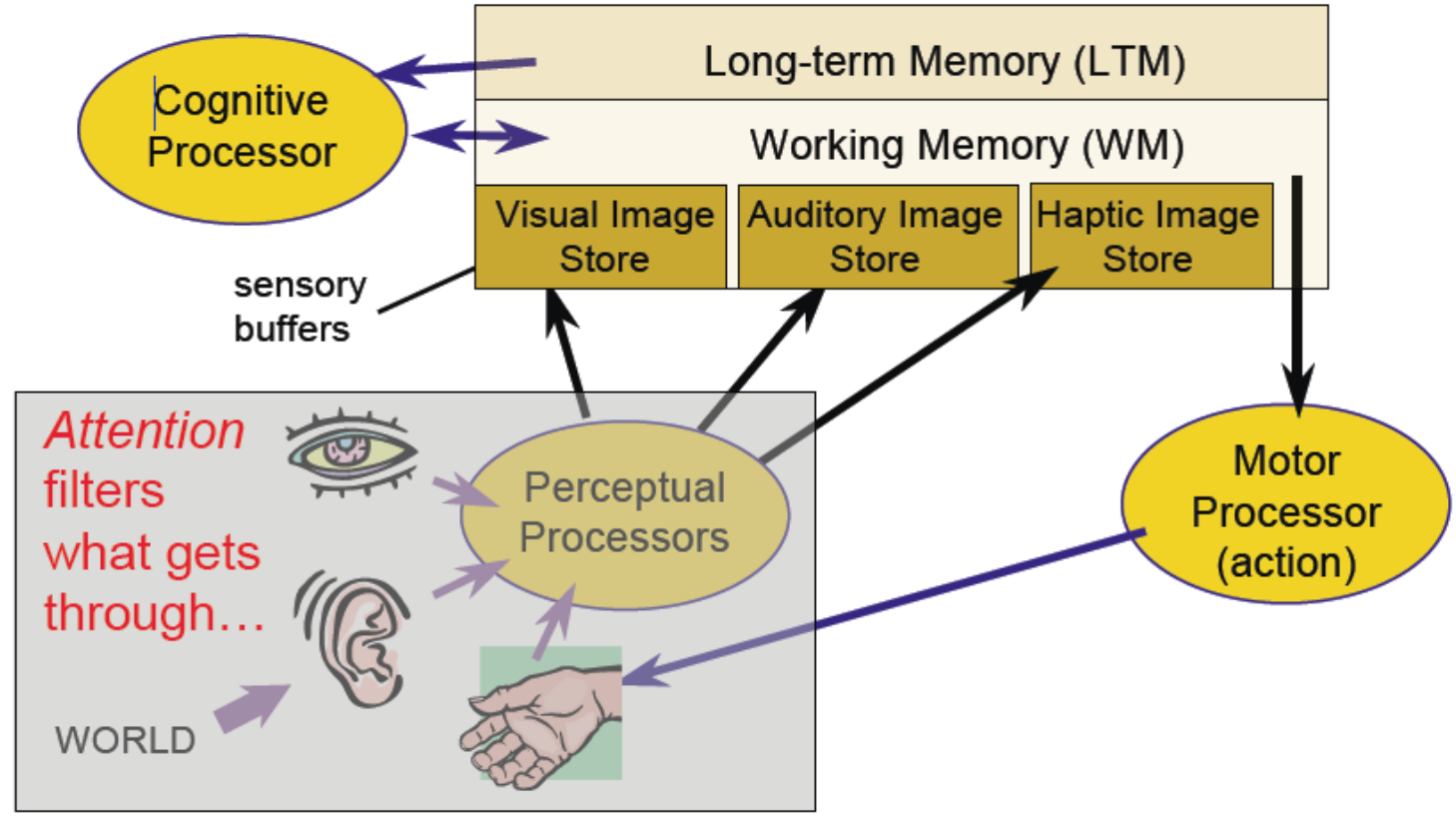
Model Human Processor (MHP)



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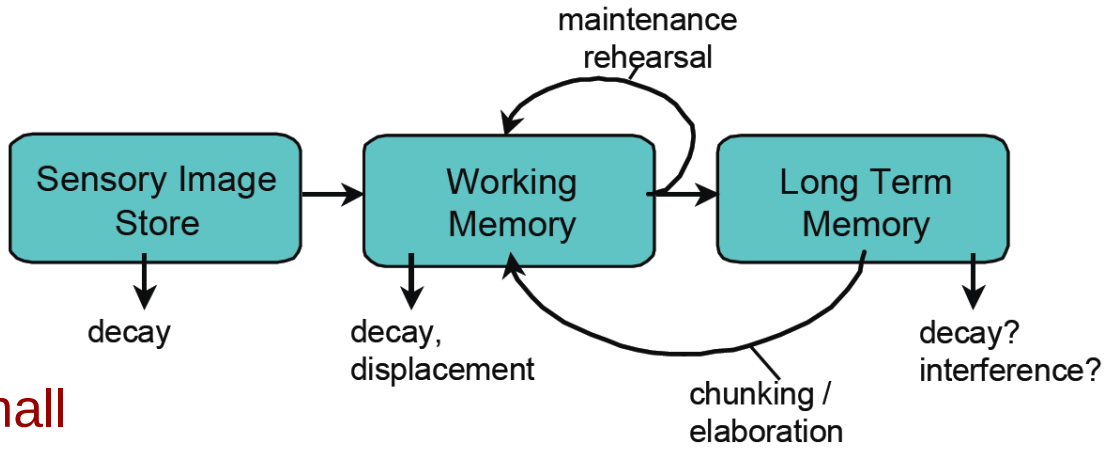
Types of human memory

- **Sensory memory**
  - Buffers: iconic (visual), echoic (auditory), haptic (touch)
  - *"allowed" into short-term memory by **attention (filtering)***
- **Working memory is short-term**
  - Rapid access (~ 70ms) & decay (~200 ms)
  - Limited capacity ("scratch-pad"): **7 ± 2 "chunks"**
  - "**flush" when finished with a task**
  - *or, move into long-term via conscious **rehearsal***
- **Long-term memory is slower, larger**
  - Virtually unlimited capacity (how many words do you know?)
  - Slower access time (~100 ms) with little decay
  - Access is a complicated operation that depends on recent past

Memory pipeline: Stage theory



- Working memory is small
  - Temporary storage: decay, displacement
- Maintenance rehearsal
  - Rote repetition
  - Information must be meaningful to learn information well
- Answer to problem is organization:
  - Fá Dó Sol Ré Lá Mi Si (what is this?? Remember music classes?)
  - Frade ao sol reza a missinha
- ***Chunking is one kind of organization***

Different ways to access memory

- Recall
  - Info must be reproduced from memory.
- Recognition
  - Presentation of info provides knowledge that info has been seen before.
  - Still some recall, but easier because of **cues to retrieval.**

e.g., command line (recall) vs. GUI (recognition) interfaces

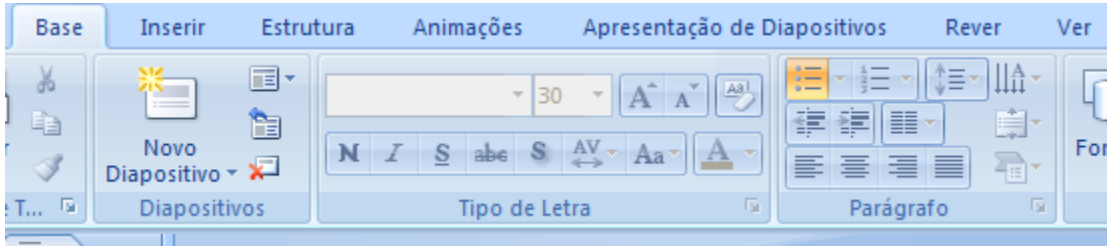
- Later, this one will show up as a *design heuristic!*
- So - why not ALWAYS design for recognition?

Facilitating retrieval: cues

- **Cue** = any stimulus that improves retrieval
  - Example: giving hints.
  - Other examples in software:
    - Icons, labels, menu names, etc.
- Anything related to
  - Item or situation where it was learned
- Can facilitate memory in any system
- What are we taking advantage of?
  - Recognition over recall

Memory chunking & UI Design

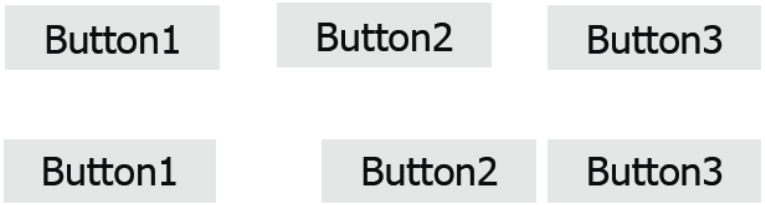
- Remember: 7±2 is our limit.
- Chunking extends capacity of WM:
  - 6174591765 vs. (617) 459-1765
  - DECIBMGMC vs. DEC IBM GMC
- Create cognitive chunks in UI design:



- Organization: progress from **general to specific**

Chunking: How to?

- Visual separation
  - Use whitespace to separate group info



- Visual differentiation
  - Change visual characteristics of groups
- Visual progression
  - Rely on visual and cognitive cues to guide order in which users internalize information

Reference from Interface Mafia - http://www.tobyrush.com/software/imob/index.html

Resources

1. Kellogg S. Booth, Introduction to HCI Methods, University of British Columbia, Canada http://www.ugrad.cs.ubc.ca/~cs344/current-term/