IPM 10/11 – T1.2
Limitations of the human perceptual system

Licenciatura em Ciência de Computadores

Miguel Tavares Coimbra

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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.***

Other senses

- Vision considered dominant in UI design: this is short-sighted ☺ and changing rapidly.
- Audition, touch are critical in our non-HCI information-gathering & interaction with the real world.
- seen less in synthetic interactions because technology hasn't caught up with our bodies.

→ hot research area!

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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Other kinds of S/R incompatibilities

- Limb to limb
- Sensory / motor channels
- Directional
- ???

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)
- max Morse code rate can be similarly calculated for audio perception times

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

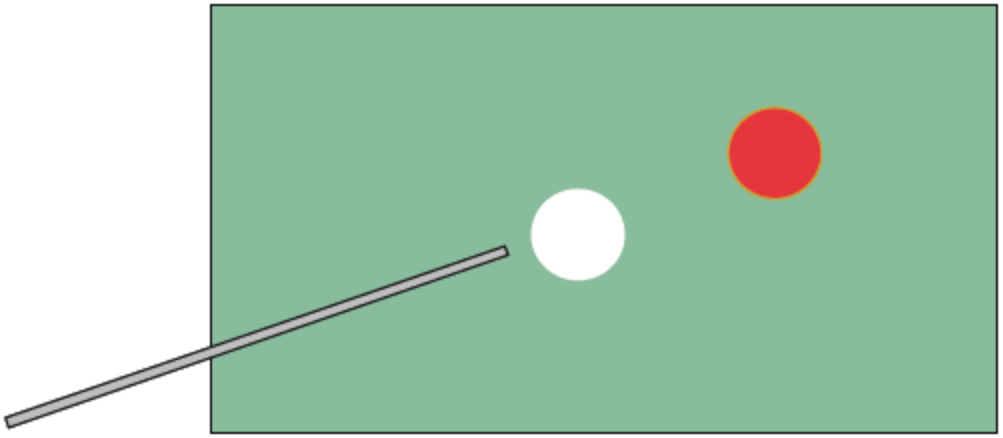
Perceptual causality

- 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?

Perceptual causality - Example



How soon must the red ball move after the cue ball reaches it?

- must move in < Tp (visual synchrony)

Does it make a difference if:

- you're holding the cue?
- can hear the ball?

Pause: Limitations of the perceptual system

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Topic: The *Model Human Processor* (MHP)

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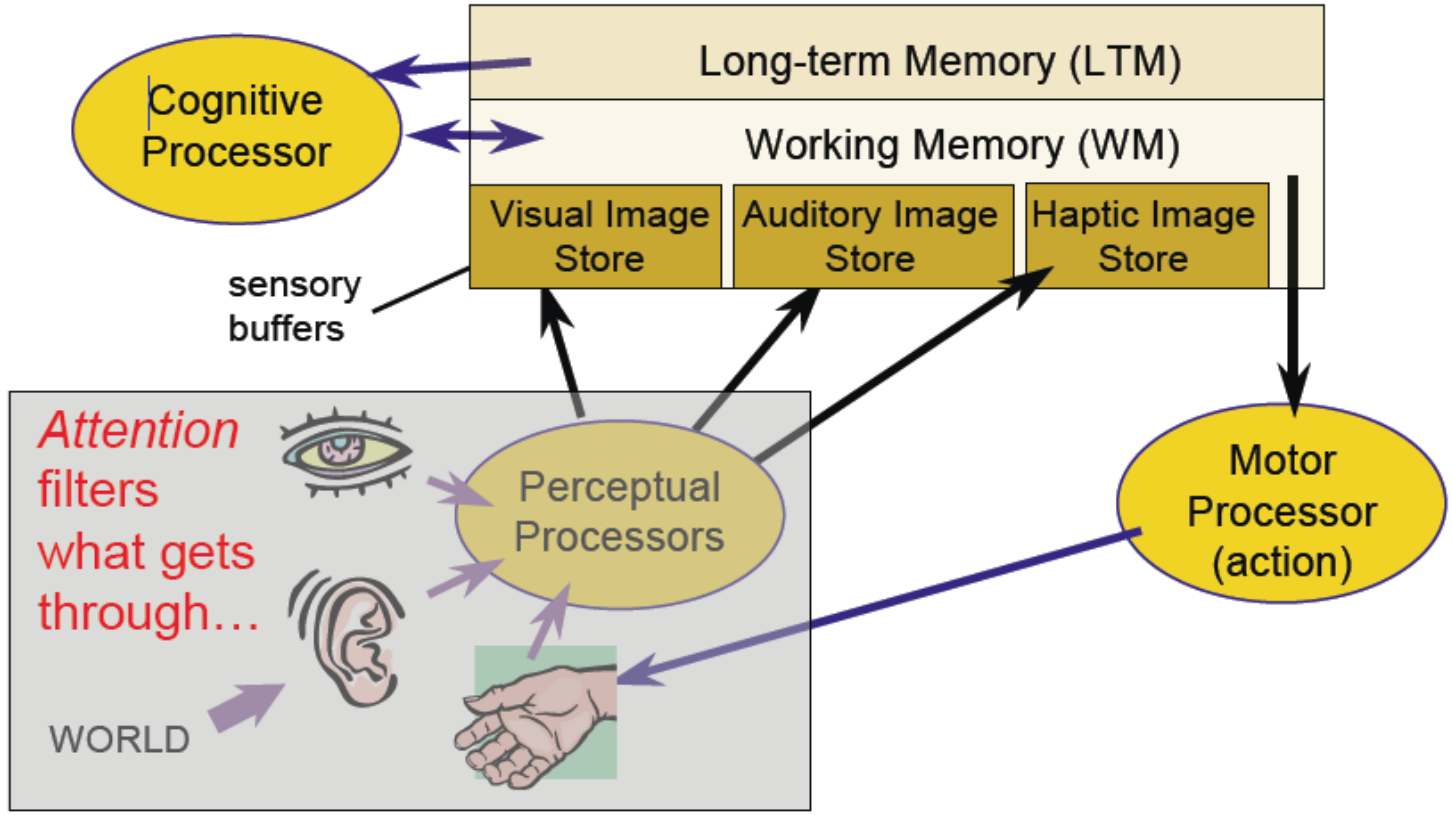
A model of human info processing

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

Topic: Memory

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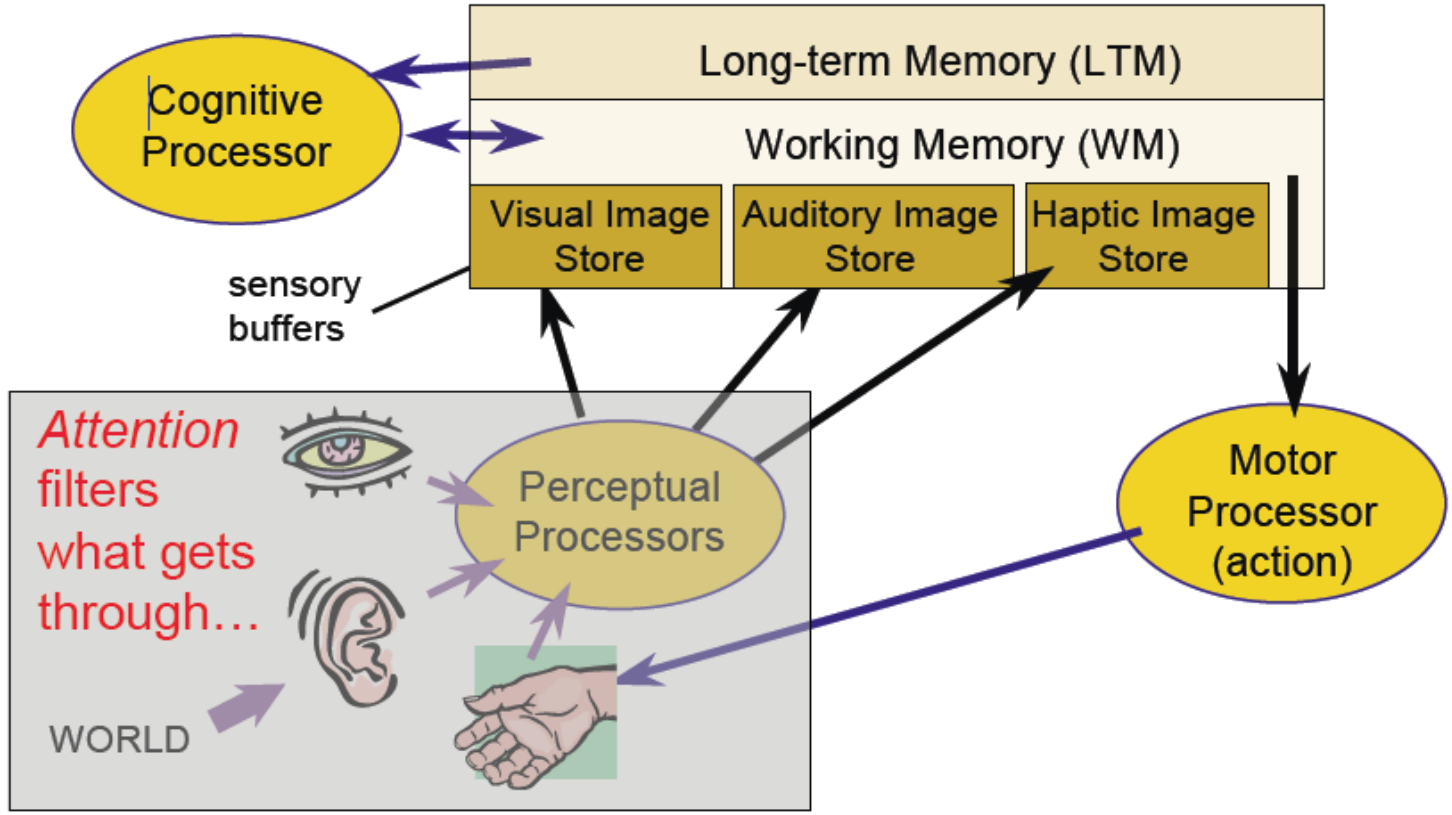
Model Human Processor (MHP)



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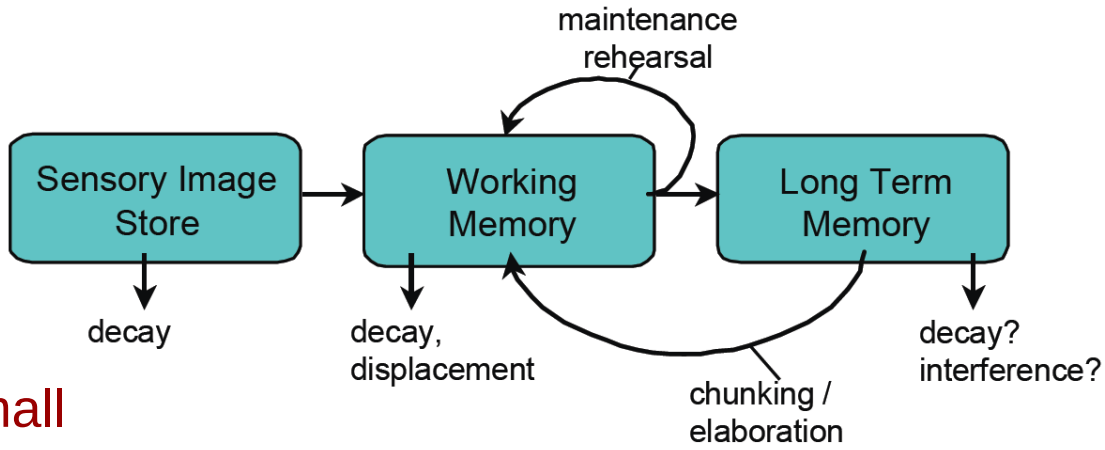
Types of human memory

- **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

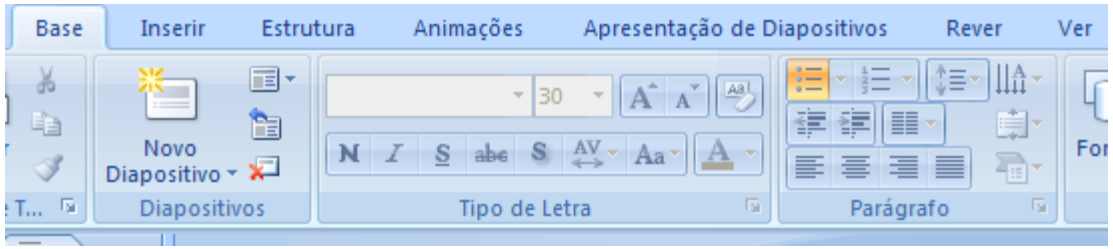
- Later, this one will show up as a *design heuristic!*
- So - why not ALWAYS design for recognition?

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 many?

- Chunking menus:

Not enough groups

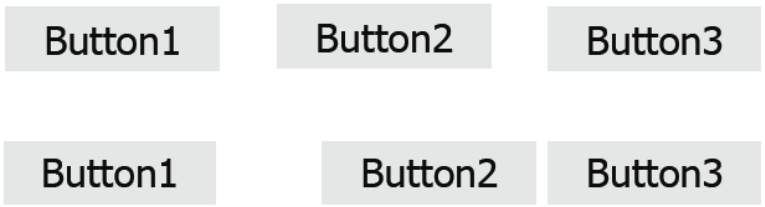
Too many groups

Just right?

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

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

Motor chunking: Gestures

- Sequence of actions completed automatically once set in motion
  - e.g., typing the word “the”
    - Single gesture for experienced typist
    - Three gestures for novice typist
  - e.g., keying in phone numbers, passwords
- Haptic analog to visual chunking
- UI guideline: facilitate gestures/phrases that result in haptic (gestural) chunking

Exploiting motor chunking

- Dvorak keyboard layout facilitates chunks:
  - common pairs become “rolls”: t h
  - other pairs alternate hands: th e m

Dvorak Keyboard Layout

layout from http://www.mwbrooks.com/dvorak/layout.html

Resources

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