
IPM 11/12 – T1.2

Limitations of the human perceptual system

Licenciatura em Ciência de Computadores

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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!

Paper
Home
Back
Schedule
Change
Page

Simple experiment ...

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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 $< T_p$ (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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Topic: The *Model Human Processor* (MHP)

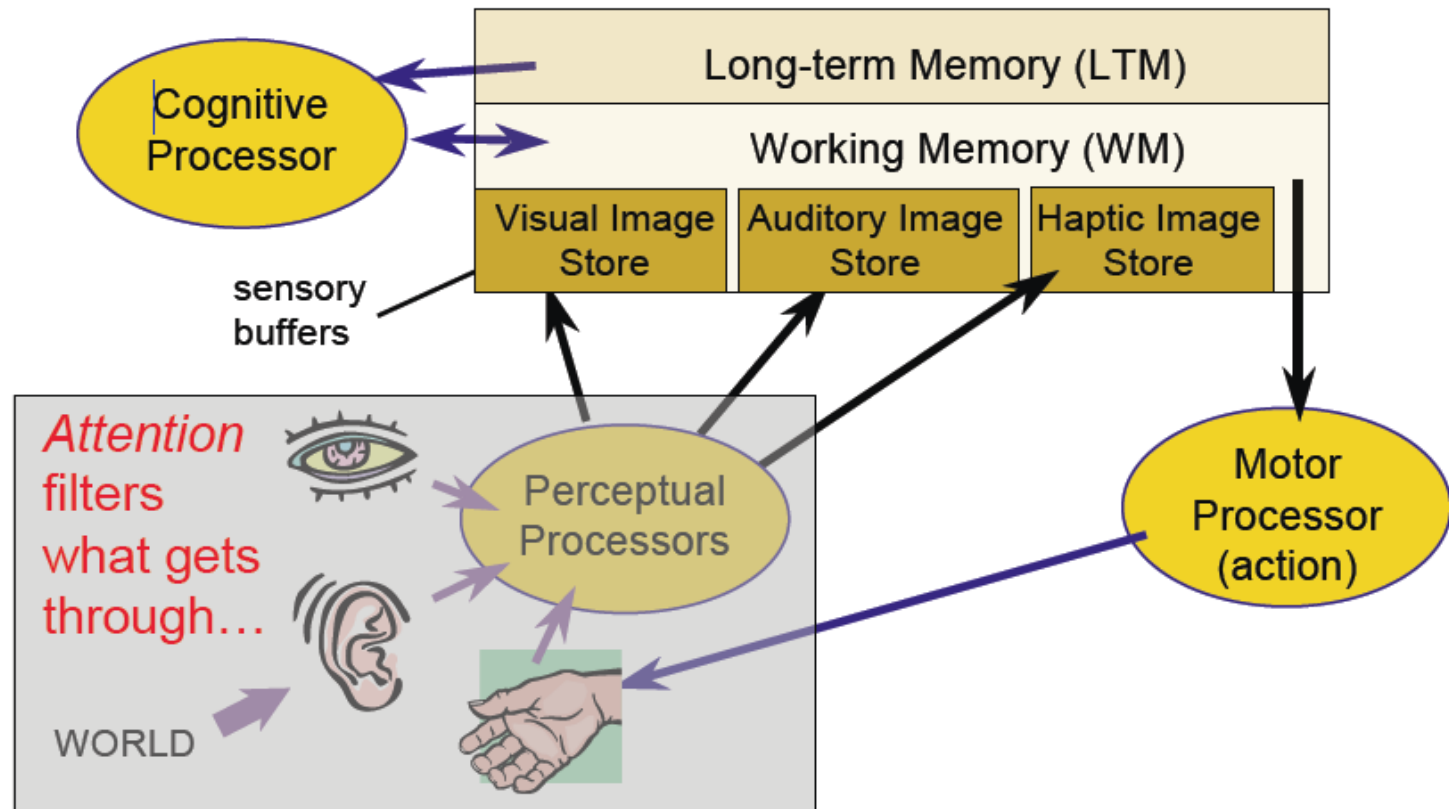
- Human abilities
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A model of human info processing

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

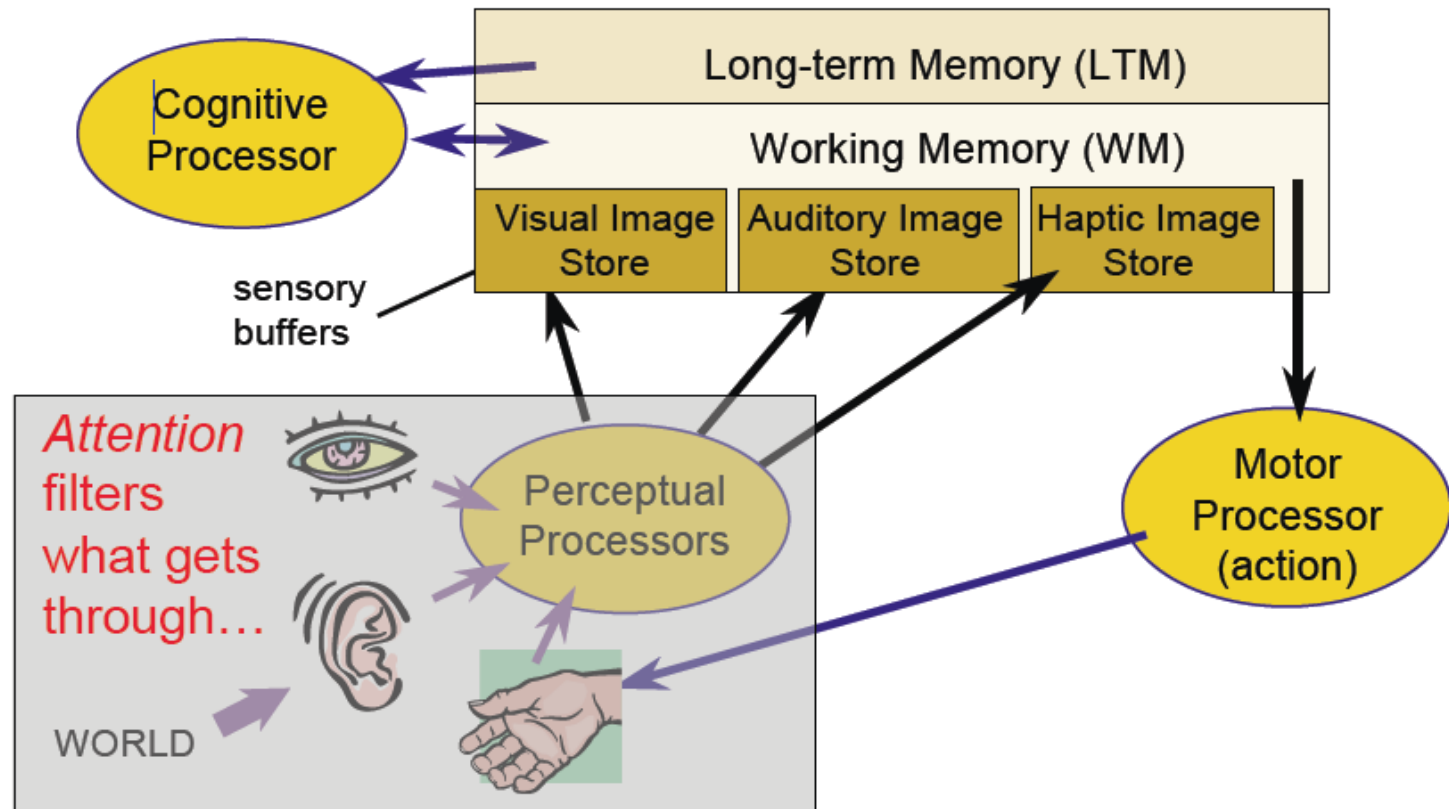
Summing up

- 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)

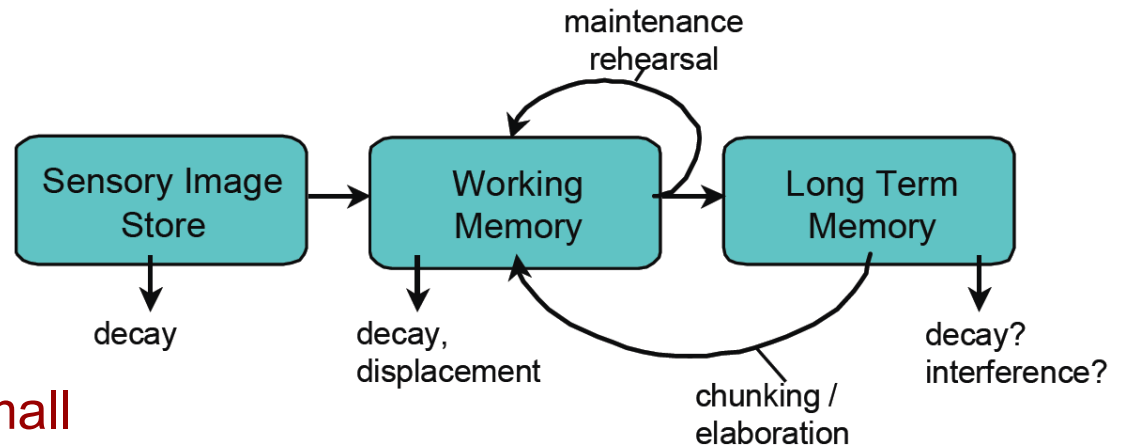


"The Psychology of Human-Computer Interaction", 1983 Card, Moran, & Newell

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

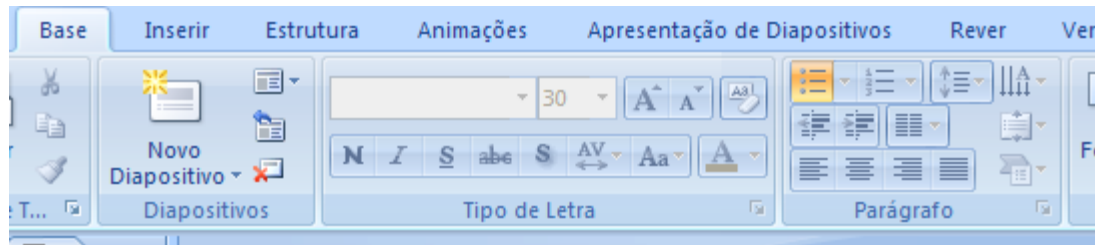
- Later, this one will show up as a *design heuristic!*
- So - why not ALWAYS design for recognition?

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?

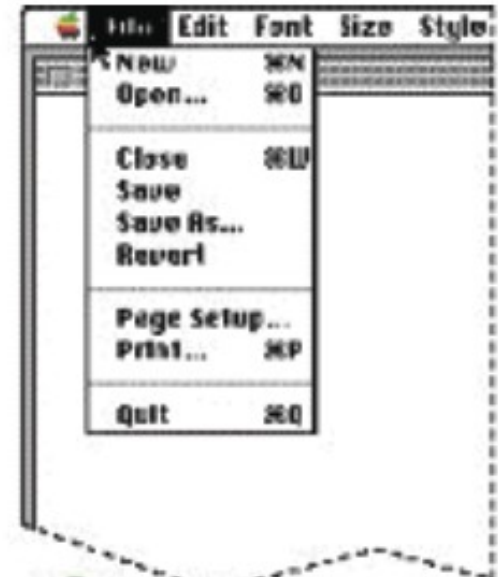
- Chunking menus:



Not enough groups



Too many groups



Just right?

Reference from Interface Mafia - <http://www.tobyflush.com/software/imob/index.html>

Chunking: How to?

- **Visual separation**
 - Use whitespace to separate group info

Button1

Button2

Button3

Button1

Button2

Button3

- **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/>